MACHINERY.

April, 1906.

THE HEATED PISTON ENGINE.

CHARLES R. KING.

IN engines of large size running at moderate speeds jacketing the cylinders with steam either at the same or at a higher temperature than that supplied to the cylinders has long been recognized as favorable to economy. The effect of the steam in the jacket is to reduce the rise and fall of the cylinder temperature due alternately to the admission and to the early cut-off and expansion of the steam. If steam of high temperature is used in the jacket the working conditions in the cylinder are of course more favorable than where steam of a temperature corresponding to the boiler pressure is used. An alternative method that has been proposed is to employ boiler steam without superheat for the jacket and also to supply boiler steam to the inside of the piston by means of a hollow piston rod. Such an arrangement would be perfect for the back end of the cylinder but at the front end where the piston rod must necessarily pass 50 per cent of its working life outside of the cylinder thereby causing a loss of temperature in the front end of the cylinder, the conditions are not so favorable; but the loss from this cause can at least be mitigated by means of the hollow piston rod filled with boiler pressure steam.

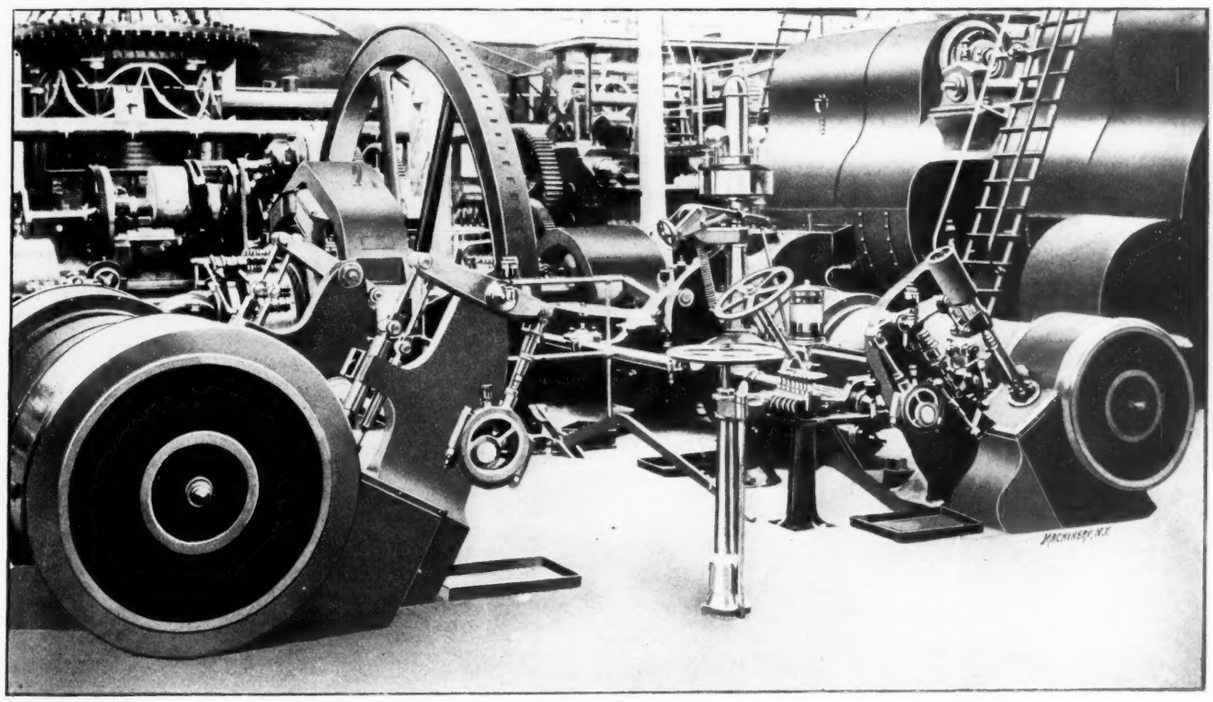


Fig. 1. Compound Engine, Jacketed, and with Heated Pistons. Built by John Cockerill, Belgium.

The suggestion that the piston shall be heated has been made several times in the past years and in particular by Lacroise in 1895 and it was again recommended in 1896 by the technical committee charged with the preparation of the steam engine programme for the Brussels exhibition. The study of the subject was then taken up by W. M. Francois, an engineer of the designs department in the great steel works of the Société Anonyme John Cockerill of Seraing near Liége, Belgium.

The heated piston was first applied in 1901 to a Corliss engine that had been laid aside in one of the shops. This was a single-cylinder non-condensing engine and in 1902 the results obtained from it were so satisfying that the machine was fitted with a condenser. It then worked with such remarkable efficiency that in 1903 a specially-built engine was constructed with Racher valves and in 1904 an engine with piston steam valves, and with cut-off or expansion valves worked by trip gear, was built and gave yet better results. A machine later exhibited at Liége International Exhibition is similar to the last engine mentioned. A general view of the engine as installed at the Exhibition is here given together with the drawings. The piston, it will be seen, consists of two hollow heads bolted by their inner faces to a hollow sleeve having flanged ends and which gives the hollow piston a total length equal to one and a half times the stroke of the piston. The separation of the piston heads by an interval equal to the length of the stroke allows direct contact of the steam within the piston against the cylinder walls. The method of securing the piston heads to the piston rods is specially designed to prevent them from working loose and also to free the rod from all stresses due to re-action in the inside faces of the piston heads. The rear piston is keyed to the rod itself while the latter is screwed in the reinforced end of the piston tie or sleeve.

The cylinder is of unusual construction. It consists of two parts, set in the outer casing or jacket in such way that there is always communication between the jacket space and the neutral space between the two piston heads. Steam thus interchanges between the jacket and the space between the pistons. There are only two flanged joints in the cylinder, as in ordinary cylinders, these joints being situated a little way back from the cylinder ends. Each half of the cylinder proper is cast in one piece with the cylinder end which comprises the jacketed end cover and the valve chest. The two cylinder ends are bolted together by means of the short barrel casing forming the mid length of the steam jacket. The three distinct parts are rigidly secured together and in due alignment by means of the flanges mentioned and by the ribbed seatings located near the inside extremities of the cylinders which per-

mit of temperature movements in the cylinders. The cylinder proper is entirely enveloped in steam and always has over 50 per cent of its length filled with steam of the pressure and temperature of that supplied to the valve chests. The efficiency of this internal heating is increased by the action of the hollow piston which keeps the steam entering at the middle of the jacket in continual movement while it also drives out at each stroke any water which may have condensed in the cylinder jacket. Particular care is taken to prevent any such condensed water from being carried through into the cylinder. By reference to the end cross section at the valve chest it will be seen that deep cavities are formed around the ends of the valve chest where such water would be carried, and at the lowest end it is drained away by an automatic forge cock and at the upper end the valve chest liner projects much above the lowest annular space of the steam chest. The piston valves being hollow, the steam circulates through them and so around the whole circumference of the cylinder.

The objects of the new form of steam distribution here employed are to permit high pressures and speeds and to keep the clearance volumes as low as possible—that is, at about the same as obtained with Corliss valves. The type of duplicate valve employed in this engine is that of Meyer and Farcot. The outer valve is the steam valve actuated direct from the eccentric and its articulated connections; the inner valve is the expansion or cut-off valve released by trip-gear. In the valve liner are two parts, one corresponding with the large opening in the wall of the cylinder, and the other, opposite and lower down, with the exhaust. In the half-tone illustration the exhaust shown is from the high-pressure to the low-pressure cylinder—the engine being of the cross-compound type.

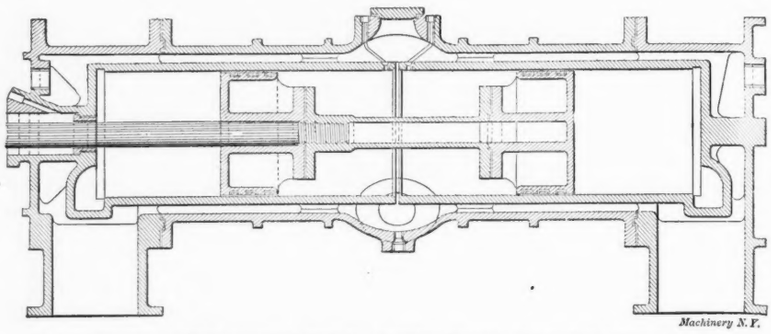


Fig. 2. Section of High-pressure Cylinder showing Method of Admitting Steam between Piston Heads.

The main or steam admission valve has in its upper half a port milled in its side to correspond with the cylinder port; and its lower half is so contracted, through a part of its length, that there is an annular passage around it for the exhaust from the cylinder. This valve is operated by the right-hand spindle (see cross-section of cylinder). On the inside of this valve works the cut-off piston valve operated through the central spindle. When the main valve is lowered it admits steam; when raised it exhausts the cylinder. The action of the expansion or cut-off valve is as follows: Fixed at the upper extremity of its spindle is a small piston working in a cylindrical box containing a helical spring. This box is fixed to the spindle of the other valve and it is guided in a cylindrical fixed bracket (see Fig. 1).

During the upward travel of the main valve the inner valve must follow it, because the piston guide of this latter is then seated at the bottom of the cylindrical box fixed to the extremity of the main valve spindle. Consequently the cut-off valve in this position keeps the steam port in the main valve covered. At the top of its travel the expansion valve is caught and held up by means of a tappet *A* articulated about the mid length of the expansion valve spindle, which, in rising, becomes engaged in a lip upon a trigger lever *T*, where it remains practically fixed during the downward travel of the steam admission valve. The cut-off valve, however, is permitted to follow and so keep near to the port in the main valve in order that, at the instant of release it may have a minimum of distance to travel in the shortest space of time possible. It may be added here that this result, previous to release, is realized by the arrangement made in connection with the trigger lever *T* pivoted at *P*, which lever can be depressed within the limits permitted by a coiled spring in the dashpot *D*, through the intermediary of the fulcrum-lever *F*. The release of the cut-off valve takes place when the striking lever *S*, turning on the center at *C*, by means of the articulation shown in connection with the eccentric strap, presses upon the trigger lever in disengaging the tappet *A* from the support.

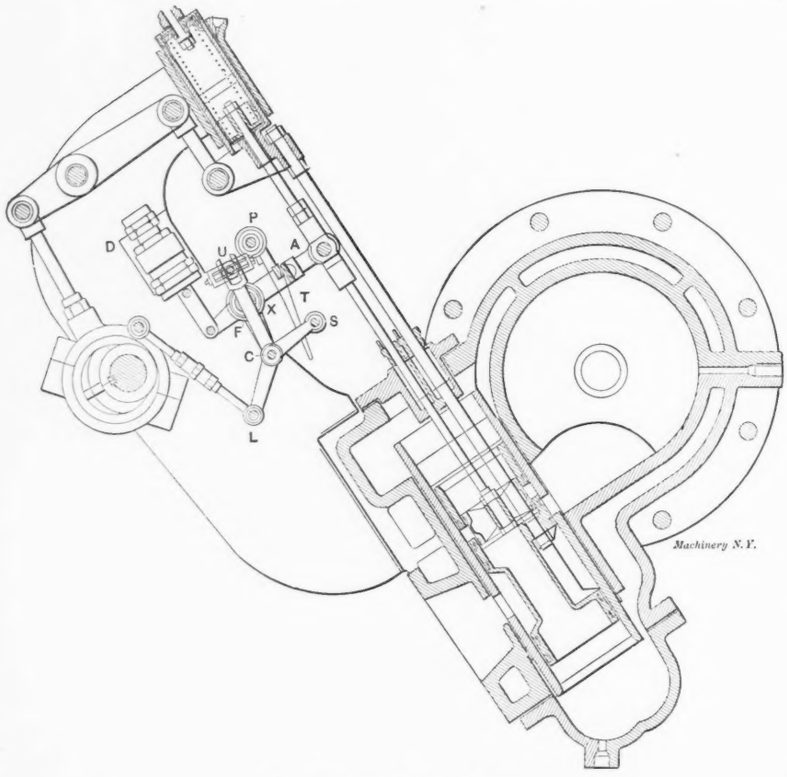


Fig. 3. Details of Valve Gear.

The main valve stem in its descent had compressed the spring contained within the box at its extremity and this spring when the release of the trigger-lever occurs, projects the cut-off valve downward over the steam port in the main valve. High piston speeds are favored by this arrangement for while the steam valve is connected direct with the eccentric motion, the fall of the cut-off valve, depending for its speed upon the elasticity of the spring, remains practically invariable for all speeds.

Very short cut-offs are effected by giving a certain amount of advance to the trip gear in anticipation of the rearward course of the piston. The admission may be varied from 0 to 60 per cent of the stroke but the height of fall for the expansion-valve remains nearly constant and the speed of the engine always above 120 revolutions (the engine illustrated is of 300 H. P.). The governor regulates the speed by changing the point of cut-off, and therefore the degree of expansion, through variations in the position of the arm *S O* in its relation to the arm *C L* and therefore with respect to

the eccentric, this being effected by a crank keyed upon the axis X, and acting upon the forked lever U. The axis or shaft X is, it may be added, turned by the sleeve of the governor.

In the machine illustrated, the second of its type, the governor is only connected to the valve mechanism of the high-pressure cylinder, the regulation of the low pressure valve motion being effected by hand. The distribution at each of the four valve chests can be modified at will even while the machine is running. In the case, however, of engines working under heavy loads liable to considerable and sudden fluctuations the arrangement can be combined so as to regulate the low-pressure cylinder, also from the governor. Despite the seeming complication of the valve mechanism it is in reality a very simple form for trip-gear machines, since there are only fourteen joints for the distribution and exhaust at each cylinder end.

The clearance volumes (piston clearance and steam passages) average, in ratio to the volume swept by the piston in each stroke, 2.88 per cent for the small cylinder and 2.6 for the large cylinder, proportions which are certainly not remarkable; but as regards the surfaces of those volumes—which are of more importance than cubic content—they have been diminished to an extent seldom realized, these being, in ratio to the pistons' surface, only 3.68 per cent (averaged) in the small cylinder, and 2.95 per cent (averaged) in the large cylinder.

The cylinders have diameters of 375 mm. (14.76 inches) and 650 mm. (25.59 inches), with an equal stroke for both of 750 mm. (29.53 inches). The piston rods are 75 mm. (2.95 inches) diameter for both cylinders.

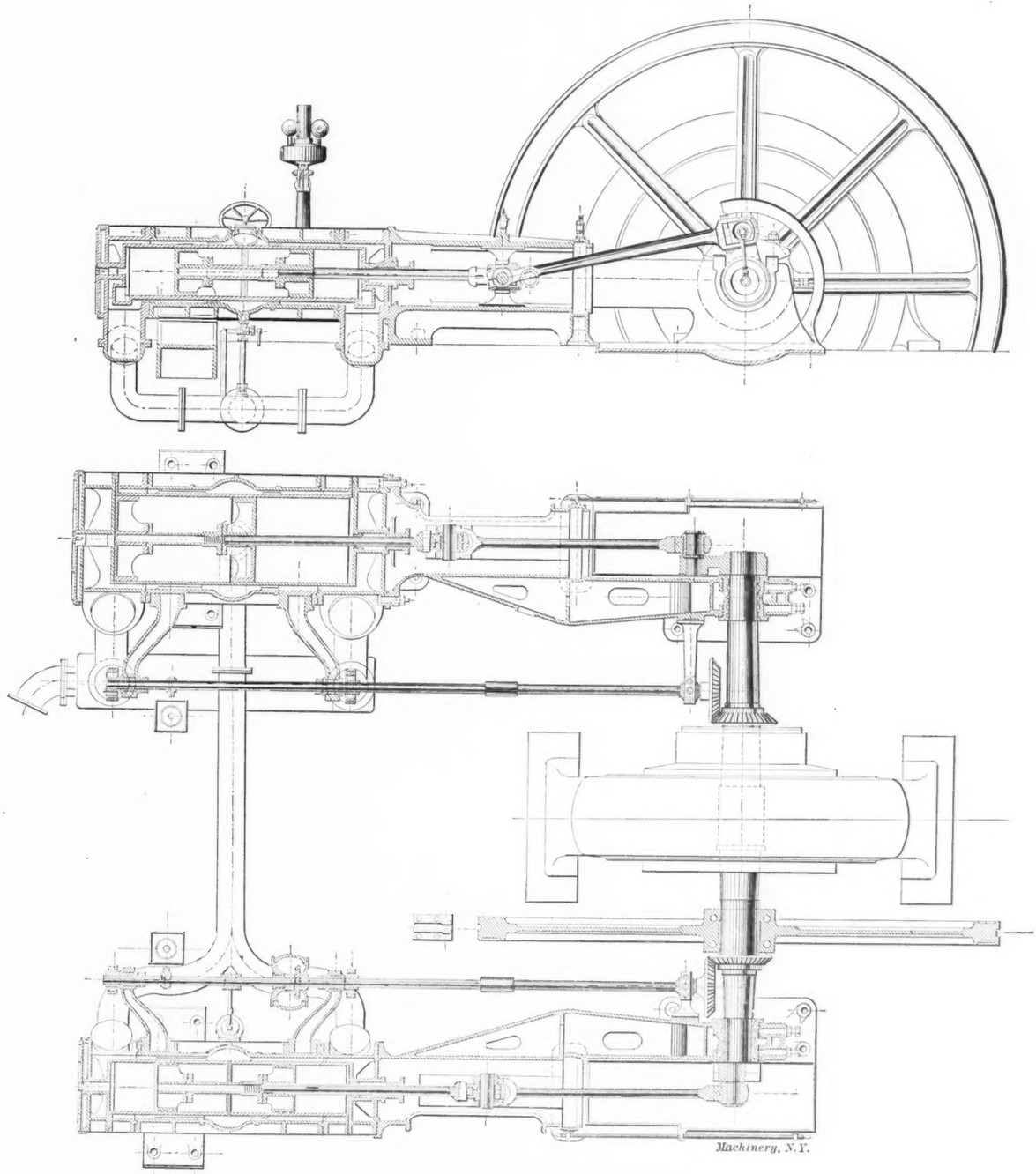


Fig. 4. Sectional Elevation and Plan of Cockerill Engine.

The receiver for the high-pressure exhaust is replaced by the steam jacket itself of the low-pressure cylinder—a practice largely followed in the Cockerill engines at Liége, including the 10,000 H. P. rolling mill engine standing alongside the machine under mention where the three high pressure cylinder jackets serve as the intermediary reservoir between boilers and engine.

A very elaborate series of trials conducted by the eminent professor of the Liége University, Mr. W. H. Hubert, showed that this engine has a high mechanical efficiency. Designed

for a nominal output of 265 H. P., it can develop 400 H. P. and while running light it only absorbed 23.8 H. P. of its own power. In six different tests the steam consumption varied from 5.09 kilogrammes to 6.06 kilogrammes per metrical horse power hour under conditions of which two examples are cited in the subjoined table.

In column 2 the engine worked with an excellent vacuum in the condenser, but without superheat, and yet the result, in calories per horse hour, is remarkable, it being very little inferior to engines working with high superheat.

	No. 1.	No. 2.
Water evaporated ...pounds..	2425.082	2118.639
Consumption per horse power hour .....pounds..	11.953	11.225
Barometric pressure...inches..	29.881	30.098
Gage (metallic) pressure..... ..... pounds..	127.126	125.32
Indicated pressure ...pounds..	19.817	20.282
Vacuum (mercury) ...inches..	26.236	27.885
Initial (admission) temperature .....deg. F..	380.6	355.13
Saturated steam temperature corresponding to 10.deg. F..	353.8	354.99
Condensed water temperature, ... deg. F..	109.4	89.6
Pressure in receiver of L..... .....pounds per sq. inch..	4.55	1.848
B. T. U. expended per H. P. H..	14377.254	13360.652
B. T. U. allowing for 16.....	13450.726	12713.472
Thermal efficiency, based on last item	18.86	19.83

* * *

DESIGNING TWO-POINT BALL BEARINGS.

Ball bearing practice has in late years crystallized into the use of the two-point form almost entirely, this having been found to be the most durable and efficient of the various possible arrangements, as well as the easiest and cheapest to construct. For obtaining the dimensions of the cups and cones in a bearing of this type, the following formulas may be used, in which

D = Diameter of the ball.

R = Radius of the tool used to form the race.

X = Smallest diameter of the cone portion of the track.

Z = Largest diameter of the cup portion of the track.

S = Available space for ball between the cup and cone surface, including clearance.

n = Number of balls.

Y = Diameter of pitch circle through the center of balls.

A, B and C represent dimensions shown in the cut in the April data sheet, sent herewith. The clearance between neighboring balls is taken as 0.003 inch.

$$A = R - \frac{D}{2}$$

$$C = A \text{ Sin. } 26^\circ$$

$$B = A \text{ Cos. } 26^\circ$$

$$S = 2(R - B)$$

$$S - D = \text{clearance of ball}$$

$$Y = \frac{D + .003}{\text{Sin. } \frac{180^\circ}{n}}$$

It will be noted from the cut that the pressure angle is 26 degrees, measured from a line perpendicular to the axis of the journal. Where the pressure is largely end thrust it will be well to take this pressure angle as 26 degrees from a line parallel with the axis of the shaft, using dimension B in place of C and *vice versa*.

In the data sheet sent with this issue of the paper will be found tabulated dimensions for ball bearings of this design, for balls from ¼ inch up to ¾ inch, using from 8 to 30 in each bearing. These dimensions of course apply only to bearings made as were those shown in the cut, with the pressure angle of 26 degrees measured from a line perpendicular to the axis of the journal. When made as suggested above for cases where the end thrust is the more important factor, the dimensions for B and C will have to be transposed. This gives new values for S, $S - D$, X and Z.

THE TEACHING OF MECHANICAL DRAWING.

E. H. FISH.

The teaching of mechanical drawing has always been, so far as the writer knows, a very unsatisfactory matter. The graduates of our high schools and colleges and even of our correspondence schools and technical schools have always fallen short of the expectations of their employers and, if the truth were known, probably have disappointed their instructors. To the shop-educated draftsman this is an anomaly, for to him the mere making of an understandable drawing is the simplest possible thing. Drawing has been called a universal language. If we can look at it as a language to express thoughts rather than as an art, perhaps we can get a better solution of the problem of teaching it. A very distinct dissimilarity between class room work as usually carried on and work as done in drafting offices is to be noticed in at least two respects. First: Class instruction (and correspondence instruction) makes extensive use of the copying of drawings. In copying I include not only the direct copying on the same scale, but also changing the scale. Second: Drawing from models, which is analagous to building a machine and making the drawings afterward.

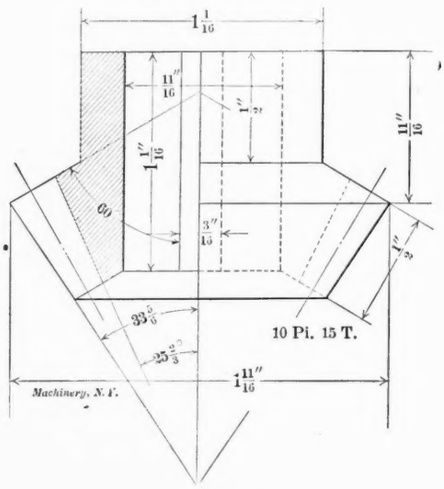


Fig. 1.

Copying, even in its broader sense, is rarely done in drafting rooms. Occasionally a machine is designed which is precisely the same as some other machine of which drawings are already on hand, but this is very rare, for in a line of sizes of machines it seldom happens that they are in direct proportion. The second, drawing from models, is rarely used in drafting rooms. Now if a draftsman does not earn his living by copying drawings or drawing from models, how does he live? My answer is: He draws on paper what his imagination sees. That is he conceives a machine or a certain part of it to be of a certain size and shape. It is not easy for him to convey this impression to the workman by ordinary written language. It may be possible for him to do so, but if he does describe it verbally, he takes long chances of being misunderstood. If he is an expert he may make a perspective drawing of what he wishes made and to another expert it will convey some meaning as to proportion, but not an exact idea of sizes. If he is an ordinary man he can make an ordinary (orthographic) drawing which will be readily understood by an ordinary workman. This is the object, then, that we must have in view in teaching drawing, that we must teach the student to first get a clear mental picture of what he is to draw, and then to draw it. A designer evolves his idea almost in its entirety before he draws a line to guide him as to how the object will look, usually making his design a composite of everything similar that he has seen and thought good. He transmits his idea to his assistants by means of sketches and verbal descriptions, both being as crude as he dares to make them. The draftsman uses these sketches, not to copy from, but as reminders and guides, making his drawings in turn from the mental picture which the designer has impressed on him. The detailer's work is to a certain extent copying from the general drawing, but even he must get a clear mental pic-

ture of what he is drawing before he can make an intelligent representation of it and dimension it.

In approaching this idea in the school drafting room, we have, of course, had to work gradually, trying and testing one feature after another, but the writer has carried the freshman and sophomore instruction under the direction of Prof. Smith far enough at this school (the Worcester Polytechnic) so that we feel sure of its good effect on the students.

We still carry on, in the Freshman year, work in geometrical drawing, given with the idea that from it the student will learn the careful use of instruments and particularly to ink in irregular curves, and also that he will become familiar with curves which he must use later in his mathematics, though this last is apart from our subject. Our work in free hand drawing still bears a faint resemblance to the usual beginner's course in that subject in that we give a few weeks' practice in drawing from models offhand, a little work in pen and ink, drawing and shading, and also a little wash drawing. Beyond this the resemblance fails. We give quite a full but simple course in a form of projection known as axonometric which is a good imitation of perspective and with a little care can be turned into perspective. The use of this enables us to give the students ordinary shop blue prints and have them make perspective drawings of the objects which the blue prints represent and without their having a chance to see the models themselves. We get very fair results, as are shown by the illustrations. Fig. 1 shows the drawing given the student to work from and Fig. 2 the drawing which resulted. If we get any results at all, we can be certain that the student has read the drawing, which is what we wish him to learn to do. While this involves just the reverse reasoning from that which we employed, at the same time it aids the student greatly by training his imagination as well as accomplishing all that can be hoped from copying drawings.

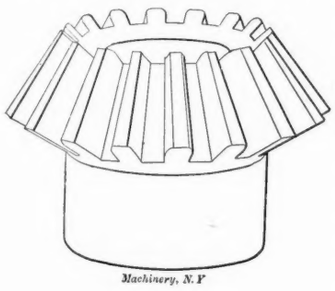


Fig. 2.

Going on further with free hand drawing, we give the students verbal or written descriptions of simple pieces, and also perspective drawings beginning with prisms and running through more difficult pieces, such as bolts, etc., and they make working drawings from this material. These are drawn and inked free hand and are dimensioned. As one of the students put it, it is mechanical drawing under difficulties. In this work, since the student has neither the model nor another drawing to copy, we are sure that he forms an impression of the object before he draws it.

We still give quite a little work both free hand and with instruments in drawing from models, principally for the practice in dimensioning. In this work the instructor takes up with the students a number of typical forms and discusses with them the different steps in the making of the patterns and doing the machine work, showing them how the pieces can be dimensioned so as to enable the workman to make them without having to figure out dimensions for themselves, and trying to impress upon them the necessity of clearly understanding how a piece is to be made before they can dimension it intelligently. We are especially careful that they shall know how every piece that they draw is to be manipulated in all stages of progress, whether in the foundry, pattern shop, forge shop or machine shop, so that later they will be careful to design details with some regard to convenience of manufacture. It has been a constant struggle previously with green "tech." graduates to get them to design castings which can be readily molded, but we feel now that by beginning early we will be able to train men who will, as a matter of habit, look out for these things. When the student is taking this course in drawing, he either has had or is having work in forge shop, foundry, pattern shop and machine shop so that his knowledge is growing uniformly along consistent lines.

After this we give them an assembly drawing of some simple machine like an arbor press, made to scale on a large cross section black board and have them make detail drawings of the separate pieces fully dimensioned and also have them make an assembly drawing of another machine from free hand sketches of the separate pieces. This is followed up by the design of a number of simple parts of machines which do not depend so much for their design on computation as on common sense and observation. We find it advantageous as well as interesting for them to begin to do such simple work as this early in their course, particularly as we wish to impress some conservatism on them and not let them have the idea so prevalent among technical graduates that a design to be creditable must be entirely original and different from anything the world has ever seen.

We also have each year a design of some rather complex machine of which we turn the assembly drawings over to the sophomores to have them make detail drawings. This year this work has been on a 16-inch drill for using high speed drills. The Freshmen are using the drawings which the Sophomores made to make the patterns from, and the Juniors are doing the machine work. So the Sophomores are getting abundant chance to see how their drawings are standing the test of actual use.

We feel that this course is much more nearly in line with actual working conditions than is the usual course in drawing, and we have a decided expectation that when the men who have been through this course graduate, they will find their first work in drafting rooms easier than those who have not had this training.

* * *

CUTTER GRINDER FOR ROTARY PLANERS.

Among the interesting shop devices in use at the Schenectady works of the General Electric Co. are a number of portable machines for grinding milling cutters of the rotary planer type. One of these machines is shown in use on a Newton rotary planer in two views, Figs. 1 and 2, and Figs. 3 and 4

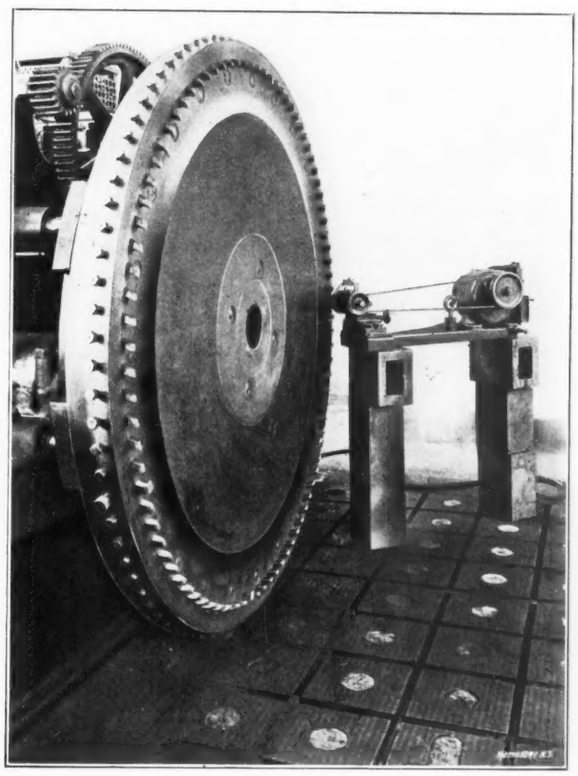


Fig. 1. Grinding the Teeth of a Rotary Planer Head.

illustrate the principle of its operation. The object sought was to grind the cutters in position in the heads so as to make each do its share of the work, and to avoid the irregular cutting action consequent with any system of grinding the cutters individually and setting them by a gage. But to grind the cutters in position with the head rotating in front of the grinding wheel it is necessary that the wheel be given an in-

and-out motion in order to grind the necessary clearance on each cutter. This motion is accomplished by mounting the grinding wheel spindle in an eccentric bushing *G*, Fig. 4, and providing suitable means for its oscillation. As the cutter *K* passes the grinding wheel *A* it engages the actuating lever or finger *C* which rocks the arm *D* on its pivot, and through its

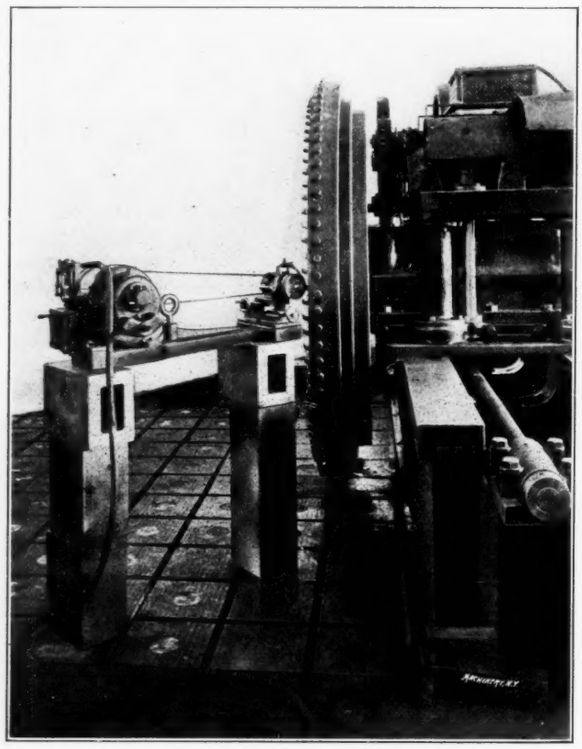


Fig. 2. Portable Grinder Mounted in Position for Operation.

intermediate connection turns the eccentric bushing and thus throws the wheel in closer to the cutter as it passes by. A coiled spring *E* retracts the finger and connected parts to the first position the moment the cutter being ground has passed beyond the grinding wheel. The finger *C* is not rigidly connected to *D* but is pivoted to it so that it has a limited independent motion, being held in the down position by a short

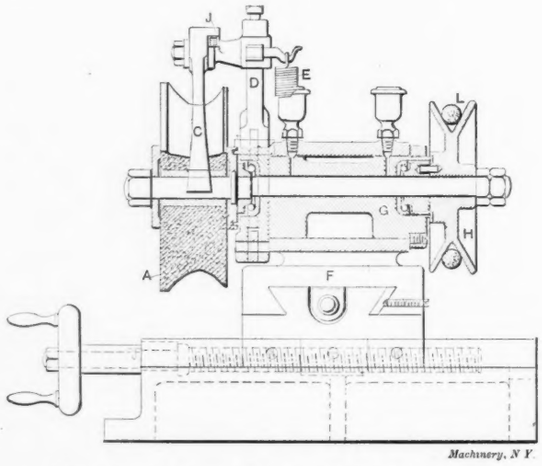


Fig. 3. Section through Spindle of Automatic Grinder.

spiral spring. The purpose of this feature is to prolong the contact of the finger with cutter in order to grind the clearance on the extreme lower corner of the tooth. The grinding wheel has a contour formed to the shape desired for the leading edge of the cutter teeth. The remaining grinding on the flat or finishing cutters is done by a flat wheel placed parallel with the face of the cutter head. It is driven by a motor connected by a round belt, as is plainly evident in views, Figs. 1 and 2 and is mounted on a compound rest so as to give it the required lateral and longitudinal adjustments for grinding. The frame carrying the motor and grinder is shown mounted on cast iron blocks, these being adjuncts of the floorplate system and in common use for blocking up heavy castings, etc.

Mr. John Riddell, who is a joint patentee of the device with Mr. Casper C. M. Mortensen, informs us that the grinder has made a great increase in efficiency of the rotary planers, and that six of them are now in use in the various departments of the works. The planer shown has a cutter head 84 inches in diameter, and after grinding it for the first time with the improved rig, the feed was increased from 2¼ to 5½ inches per minute; the character of the work was also improved, being made smooth and free from the characteristic ridged appearance which almost invariably accompanies the work of these machines. It will be noticed upon close inspection of the half-tone, Fig. 1, that six teeth are placed at equal distances around the cutter head which have extended cutting faces, being designed for smoothing the milled surface. These are ground with the other teeth in identically the same manner but of course the grinding with the formed wheel does not extend throughout the width of the smoothing teeth, the grinding being done with a flat wheel as explained in the preceding paragraph. Clearance is also provided in the same way.

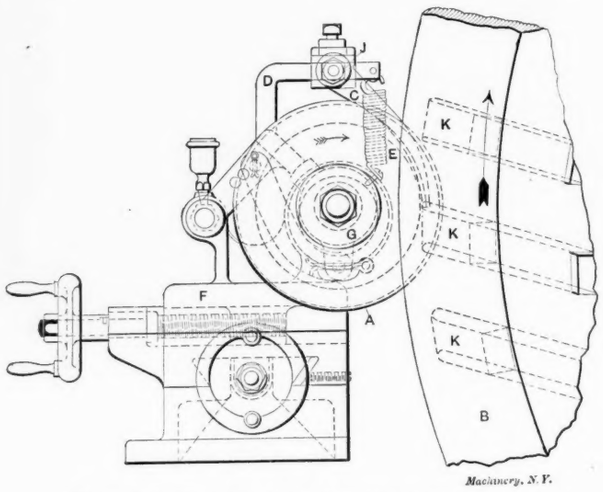


Fig. 4. Side View, showing Action of Tooth on the Finger.

Incidentally Figs. 1 and 2 show the form of floorplate adopted in the new turbine shop, building 86 of the General Electric Co. The floor-plates in this shop is 50 feet wide and 200 feet long. It is built of sections 10 feet square, all bolted solidly together with tongue and groove so that the sections make practically one huge plate. The holes shown in the center of the squares are for filling underneath the floorplate sections with grout. The plates are carefully laid on a concrete bed and leveled up, and then the space beneath is filled by pouring the grout through the holes shown until it is about level with the surface.

* * *

CORRECTION TO DECEMBER DATA SHEET.

In the longitudinal section of the boiler shown on this sheet the dimensions *M M* should represent the width of the air spaces instead of as drawn. Also the dimension *B* should be the distance between the outside of the two boiler heads and the dimension *R* the distance from the outside of the rear head to the brick wall. It may also be mentioned that the dimensions *D*, *H*, *I*, *K*, *L*, *M* and *N* all terminate on rivet lines. They are thus represented on the drawing, but the details are so small that this fact may not be entirely clear.

* * *

The *Scientific American* translates a receipt for casein cement from *Nouvelles Scientifiques* which is said to be valuable for mending broken porcelain, and, of course, any crockery ware. Mix 10 parts of freshly prepared casein (milk curds) with 30 parts soluble silicate of soda (water glass) and 20 parts soluble silicate of potash.

DESIGN OF A RIVETED JOINT.

FRANKLIN H. SMITH.

In designing a riveted joint it is first necessary to know the pressure per square inch and the diameter of the cylinder, or the thickness of the metal.

The letters in the formulas used for the design of riveted joints have the following uses; these formulas apply to joints having only one pitch:

t = thickness of the plate.
P = pressure to be resisted by 12 inches of the joint.
D = diameter of the cylinder, in inches.
a = pressure per square inch.
S = ultimate shearing strength of rivet or plate.
p = pitch of rivets.
f = factor of safety = ratio in which the bursting pressure exceeds the working pressure, and is computed by dividing the lowest resistance of the several parts by the resistance of the solid plate.
T = tensile strength of the plate.
d = diameter of the rivet hole.
B = bearing value of the plate.
l = distance from center of rivet to the edge of the plate.
b = diagonal pitch.
e = efficiency of the joint.
n = number of rows of rivets.

The value of some of the above letters are as follows:

S = 0.75 to 0.80 of the tensile strength of the plate, for a rivet in single shear, a rivet in double shear is taken as 1¾ times one in single shear.*

f = 6, for cylinders of moderately good materials and workmanship. The following additions should be made for structural defects when they exist, *viz.*, an addition of 0.25 when the rivets are not good and fair in the girth seams; 0.50 if the rivets are not good and fair in the longitudinal seams; 1.00 if the seams are single riveted; and 2.00 when the quality of materials or workmanship is doubtful or unsatisfactory.

T = for steel plates about 55,000 to 60,000 pounds per square inch; for wrought iron about 45,000 pounds per square inch.†

$B = \frac{3T}{2}$ for ordinary bearing, and, $2T$ for web bearing.

If the thickness, t, of the plate is known

$$d = \frac{\sqrt{t \times 92}}{8} + \frac{1}{16} \text{ to be taken to the nearest 16th.} \quad (1)$$

$$p = \frac{d^2 \times .7854 \times S \times n}{t \times T} + d \quad (2)$$

A riveted joint is twice as strong against circumferential rupture as against longitudinal rupture. Therefore, a cylinder which requires a double riveted lap joint for the longitudinal seams will only require a single riveted lap joint of the same diameter and pitch for the circular seams, etc.

$$P = 6aD \quad (3)$$

Now choose a trial value, d, for the diameter of the rivet hole; commercial rivets vary by 1/16 inch up to ⅞ inch, more commonly by ⅛ inch, ⅝ inch, ¾ inch; ⅞ inch and 1 inch being the most frequently used. Remember that the cold rivet is 1/16 inch diameter less than the hole, and that the diameter of the hole must be greater than the thickness of the plate, otherwise the punch will not be likely to endure the work of punching.

Substitute the chosen value of d in the following equations until the proper pitch is found. Six diameters of the rivet is the maximum pitch for proper calking owing to the liability of the plates to pucker up when being calked.

$$p = \frac{9.4248d^2S}{Pf} \quad (4)$$

for single riveted lap joints.

$$p = \frac{18.8496d^2S}{Pf} \quad (5)$$

for double riveted lap joints and single riveted butt joints with two cover plates.

$$p = \frac{37.6992d^2S}{Pf} \quad (6)$$

for double riveted butt joints with two cover plates.

Notice that twice the result found by (4) is equal to the result found by (5), and that four times the result found by (4) is equal to the result found by (6).

Having now the pitch and diameter of the rivet, try the percentage of strength, or efficiency, of the plate, by,

$$e = \frac{p - d}{p} \quad (7)$$

and if the result is not satisfactory try a new diameter of rivet and find its corresponding pitch as before.

The strength or efficiency of a well designed single riveted joint may be 56 per cent, of a double riveted joint 70 per cent, and of a triple riveted joint 80 per cent of that of the solid plate.

In determining the pitch of rivets and the efficiency of joints with punched holes the larger diameter of the punched hole should be used in determining the efficiency, and the smaller diameter or the diameter of the rivet should be used in determining the bearing value, etc., of the rivet.

$$t = \frac{f \times P \times p}{12 \times T(p - d)} \quad (8)$$

Now check the pitch, diameter and thickness by substituting these values in (2).

If the rivet fills the hole and is well driven there is no bending moment exerted on it unless it passes through several plates. Practical tests have shown that rivets cannot be made to surely fill the holes if the combined thickness of plates exceeds 5 diameters of the rivets.

Butt joints are generally used for plates over ½ inch in thickness. Where one cover plate is used on a butt joint its thickness is 1⅛ times the thickness of the plate. Where two cover plates are used each should be about ⅝ of the plate thickness.

Now check the diameter, thickness and pitch for crushing by

$$\frac{12dtB}{P} = \text{or} > Pf \quad (9)$$

for single riveted joint.

$$\frac{24dtB}{P} = \text{or} > Pf \quad (10)$$

for double riveted joint.

The distance from the center of the rivet to the edge of the plate after being beveled for calking should be $1\frac{1}{2}d + \frac{1}{8}$ inch. Check by

$$l = \frac{fPp}{24tS} \quad (11)$$

and if the result is greater than $1\frac{1}{2}d$, use it, adding ⅛ inch.

The diagonal pitch of rivet of a seam having several rows of rivets all of the same pitch is generally equal to .75 to .80 of the straight pitch and should not be less than

$$b = \frac{(p \times 6) + (\text{dia. of rivet} \times 4)}{10} \quad (12)$$

Diagonal Seams.

The ratio of strength, R, of an inclined or diagonal seam to that of a straight seam, or ordinary longitudinal seam, may be found by

$$R = \frac{2}{\sqrt{\cos \text{ of angle of inclination} \times 3 + 1}} \quad (13)$$

Rivet Material.

It is necessary to make the rivets of the same material as the plates to prevent corrosive wasting from galvanic action. That is, iron rivets should be used with iron plates, steel rivets with steel plates, and copper rivets for copper plates.

*As the rivets of a joint are protected from deterioration while the plates are thinned by wear, the shearing strength of a rivet is frequently taken as equal to the tensile strength. Also, in determining the shearing value of a rivet from the tensile strength of the plates, if iron rivets are being used with steel plates, the shearing value of the rivet must be determined from the tensile strength of iron as given above and not from the tensile strength of steel.

†The tensile strength of wrought iron plates across the grain is on an average 10 per cent. less than along the grain.

Elastic Limit of Riveted Joints of Steam Boilers.

The riveted seams of a steam boiler should cease to be steam tight for some time before the internal pressure is equal to the elastic limits of the plate. If a boiler were stretched beyond the elastic limit of the material, the rivet holes would become stretched and the joints of the plates would be disturbed, resulting in large leakage from the rivet holes and seams.

The elastic limit of riveted joints of wrought iron and mild steel is as follows:

Best quality of mild steel, 32,000 to 34,000 pounds per square inch.

Ordinary quality of mild steel, 28,000 to 30,000 pounds per square inch.

Best quality of wrought iron, 24,000 to 26,000 pounds per square inch.

Ordinary quality of wrought iron, 20,000 to 22,000 pounds per square inch.

Weight of Seams or Riveted Joints of Cylinders.

The weight of seams of cylinders varies according to their proportions and must be calculated in each particular case. A rough approximation of the weight of riveted seams may, however, be obtained by increasing the weight of the cylinder by 1-6 if formed with single riveted circumferential seams and double riveted longitudinal seams; and by 1-5 if formed with double riveted circumferential seams and triple riveted longitudinal seams.

Gripping Power of Rivets.

When two plates are fastened together by properly proportioned and well closed rivets, the frictional adhesion of the plates depends upon the longitudinal tension of the rivets. The adhesion of the plates or their resistance to sliding, per square inch of sectional area of the rivets is in a general way equal to 2-9 of the ultimate tensile strength of the rivet.

Punched Holes.

The distressing effect on the plate due to punching may generally be neutralized by removing an annulus ⅛ inch in width around the rivet hole with a reamer.

All rivet holes shall be so accurately spaced and punched that when several parts are assembled together, a rivet 1-16 inch less in diameter than the hole can generally be entered hot into any hole.

In the better class of plate work it is now the practice to drill rivet holes in plates after the plates are in place, so that the holes are sure to be fair. In some cases the holes are punched to a smaller diameter and then drilled out to final size after the plates are in place. In either case the plates are afterwards separated and the burr left by the drill removed.

The effect of clearance between the punch and die is to produce a conical hole in the plate. The punched plates are generally arranged with the large ends of the holes outside or the small ends together.

* * *

RECENT ADVANCES IN FINE MEASUREMENT.*

The limit of fineness of mechanical measurement at present attainable with absolute certainty, by the use of the most accurate micrometer microscopes or thickness measurers, fundamentally dependent on the accurate cutting of excessively fine screws, is the thousandth part of a millimeter or the twenty-five-thousandth part of an inch. The celebrated mechanical measuring machine of the late Sir Joseph Whitworth, dependent on a fine screw and on the delicacy of the sense of touch, reads directly to the ten-thousandth part of an inch. Sir Joseph Whitworth did, indeed, succeed in constructing a mechanical measurer, for the accurate determination of the length of the standard yard, which read to a millionth of an inch. But grave errors rapidly develop in such machines with the wear of the several screws employed, and a grain of dust is fatal to the trustworthiness of the sense of touch beyond the limit of the ordinary Whitworth machine just referred to. Hence, the twenty-five-thousandth of an inch may be taken as the limit of measurement of mechanical measurers of general application.

But we possess a physical means of measurement three hundred times more refined than this and free from the difficulties alluded to; that is, one which enables us to determine variations in length, thickness, or position with absolute accuracy to the eight-millionth part of an inch, or one three-hundred-thousandth of a millimeter. The foundation of this truly wonderful scale is the wave-length of light, a quantity which is now known with great accuracy for the most important lines of the spectrum.

Moreover, the method is rendered æsthetically beautiful by the fact that an actually visible scale can be produced, composed of black interference bands on a brilliant back-ground of pure monochromatic light. Further, the interval between any two bands can be subdivided into one hundred parts by employing a micrometer eyepiece on the observing telescope.

To produce the bands the monochromatic light requires to be reflected from two surfaces, almost, but not quite, in contact, one of which must be of transparent material. They must be arranged so that the intervening film of air is slightly wedgeshaped instead of being of uniform thickness, the amount of tilt of one surface with respect to the other determining the width of the bands. The value of such a scale for measuring purposes will be at once apparent when it is pointed out that if one of the reflecting surfaces approaches to or recedes from the other the interference bands also move, at right angles to their length, and that the passage of any two consecutive bands over a reference mark corresponds to a movement of the surface referred to equal to half the wave-length of the light employed. Hence, it only remains to count the number of interference bands which pass the reference mark, and to use the micrometer to determine any initial and final fractions of a band, in order to obtain the measure of the amount of motion of the surface.

This principle was first applied by Fizeau for the determination of the expansion by heat of solid substances. It has the inestimable advantage, in the case of costly or rare substances, of only requiring a small quantity of the material under investigation, a cube of one centimeter edge being ample. The principle was subsequently extended by Koch to the determination of the elasticity of thin plates.

* Dr. A. E. H. Hutton in *Times Engineering Supplement*, Oct. 18, 1905.

* * *

BOILER TROUBLE DUE TO FAULTY DESIGN.

In a paper on some steam boiler troubles read by Mr. Horace See before the November meeting of the Society of Naval Architects and Marine Engineers held in New York, reference was made to the cracking of sheets experienced in a set of plain cylindrical boilers of the form shown in Fig. 1, having mud drums, *B*, connected thereto by short tubes, *C*. These boilers were arranged to receive gases from a blast furnace, or could be fired in their own furnaces at the front end as the occasion required. The mud drums gave trouble, not as might be expected at the juncture of hats or tubes, *C*, but at the top

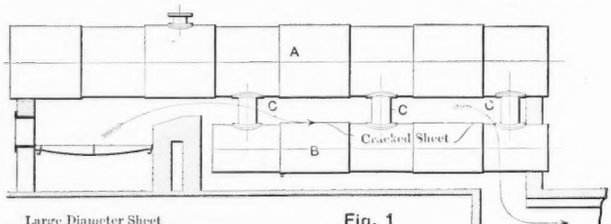


Fig. 1

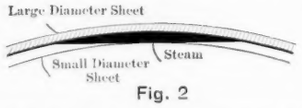


Fig. 2

of the larger diameter courses in the mud drums. The reason for this was simply that these courses, being larger diameter than the courses connected by the tubes to the boiler, trapped a small quantity of steam, about one-fourth inch in depth, as indicated in Fig. 2. The mud drum sheets above the steam, of course, became highly heated and eventually cracked; the remedy was simply to connect the larger courses of the mud drums to the boiler with additional tubes.

* * *

Chrome nickel steel is now made which with special heat treatment, has a tensile strength of 250,000 pounds per square inch of section, an elastic limit of 230,000 pounds, an elongation of 11.5 per cent, and a reduction of area of 35 per cent.

MILLING CUTTERS.

"A."

There are probably no tools more universally used in the modern machine shop than milling cutters; and no tools have to such an extent revolutionized machine shop practice during the past ten or fifteen years as have milling cutters and milling machines. Not only are they to a great extent doing work formerly done on planers, shapers, gear planing machines, slotting machines, etc., but during the last three or four years all up-to-date machine shops have been more and more abandoning the practice of using the lathe for thread cutting, and

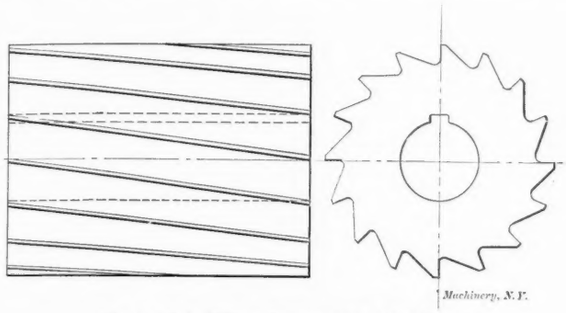


Fig. 1. Plain Milling Cutters with Spiral Teeth.

in its place using the thread milling machine. Owing to the great variety of work done, and to the wide difference between the operations performed by milling cutters, these tools are made in such an enormous number of different styles, kinds, and forms, that it would be impossible to treat them all under a general heading. For this reason each of the more commonly used kinds of milling cutters will be treated separately in the following article.

Plain Milling Cutters.

Plain milling cutters are generally manufactured in sizes varying from two to five inches in diameter and up to six inches in length. However, the writer would not advise the use of solid, plain milling cutters with a width of face greater than four inches. When a width of face of more than four inches is required, it is advisable to make such cutters in two or more interlocking sections (the various styles of interlock will be treated later).

TABLE 1. NUMBER OF TEETH AND AMOUNT OF SPIRAL OF PLAIN MILLING CUTTERS.

$$\text{No. of teeth} = \frac{5 \times \text{diam.} + 24}{2}$$

Diameter of Cutter.	Number of Teeth.	Spiral = 9 × diameter + 4.
2	16	One turn of spiral in 22 inches.
2¼	18	" " " " " 24¼ "
2½	18	" " " " " 26½ "
2¾	18	" " " " " 28¾ "
3	20	" " " " " 31 "
3½	20	" " " " " 35½ "
4	22	" " " " " 40 "
4½	24	" " " " " 44½ "
5	24	" " " " " 49 "
5½	26	" " " " " 53½ "
6	26	" " " " " 58 "
6½	28	" " " " " 62½ "
7	30	" " " " " 67 "
7½	30	" " " " " 71½ "
8	32	" " " " " 76 "
9	34	" " " " " 85 "
10	36	" " " " " 94 "

There are two very strong reasons why not only the manufacturer but also the user should prefer wide face cutters to be made in sections. In the first place the difficulty and the risk taken by the manufacturer in the various operations in making a cutter of very large dimensions, owing to the liability of such cutters cracking in hardening, ought to be sufficient to induce him to try to discourage his customers from using such cutters solid. In the second place the risk taken by the buyer is greater than when using a solid cutter, because if anything should happen to the cutter the whole cutter would have to be replaced; whereas, if made in sections only the injured section would need to be replaced, and the buyer will find that the extra cost of having the cutters made in interlocking sections will be greatly overbalanced by the saving it will give him.

Referring to the limit of diameter (five inches) given above, this is, of course, only arbitrary and cutters of much larger diameter are often made solid. It must be remarked, however, that cutters of larger than five inches in diameter ought to be made with tool steel blades inserted into a body made out of machine steel or cast iron. When making a cutter in this manner it will even be cheaper to have high-speed steel blades inserted in a steel or cast iron body than to make the cutter solid out of common, ordinary tool steel. It must also be remembered that when a cutter of this kind is worn out, the blades only will have to be replaced.

In regard to the teeth in plain milling cutters, it is obvious that a solid cutter will have a greater number of teeth than one with inserted blades, as in the latter kind; of course, some space is required for some fastening device for the blades.

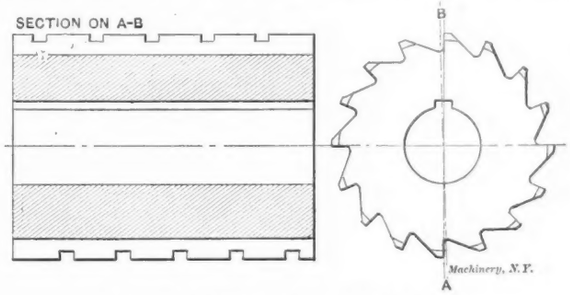


Fig. 2. Plain Milling Cutter with Notched Teeth.

In table 1 will be found the proper numbers of teeth to be used for different diameter cutters. These numbers of teeth can approximately be found from the formula

$$N = \frac{5D + 24}{2}$$

in which N designates the number of the teeth and D the diameter of the cutter. The teeth of plain milling cutters are usually cut spiral. The amount of spiral is also given in Table 1.

Although all cutters ought to be cut spiral, whatever the width of face, it has become a practice to cut the smaller sizes (up to ¾ or 1 inch width of face) straight. Some users even prefer to have all cutters, no matter what width of face, cut straight, but in order to break up the length of the cut, small grooves are cut at proper intervals in the land of each

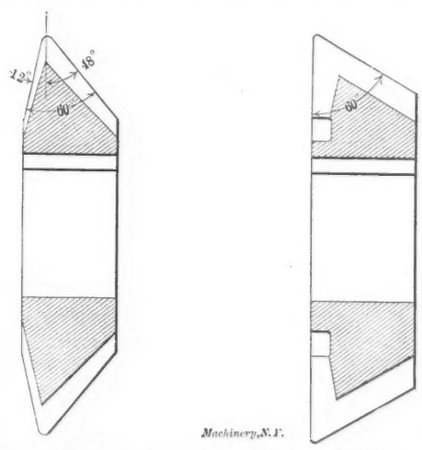


Fig. 3. Fig. 4.

Cutters used in Fluting Spiral and Straight Tooth Cutters.

tooth. The grooves in one tooth should come in the center of the cutting portion between two grooves in the next tooth. (See Fig. 2.) Cutters made in this manner are generally termed "Cutters with nicked cutting edges." Some users of plain milling cutters insist on having the cutters nicked, even though the teeth are cut spiral, and when the face of the cutter is wide, it is certainly to be recommended.

Plain milling cutters with the teeth cut spiral should be

fluted with a cutter having 60 degrees included angle; 12 degrees on one side and 48 degrees on the other, as in Fig. 3. Some manufacturers, if not all, advertise cutters for fluting spiral mills having an inclusive angle of 52 degrees; 12 degrees on one side and 40 degrees on the other. This, however, makes a rather weak and unsupported tooth. When teeth are cut straight a 60-degree angular cutter should be used, as in Fig. 4.

The relief to give the teeth of a cutter, when grinding, is of main importance. In the first place, it must be remembered that a very different relief will be the result when using a grinding wheel of the disk form than when using one of the cup wheel forms.

A glance at Fig. 5 where both reliefs are shown in exaggerated proportions, will instantly convince the reader that

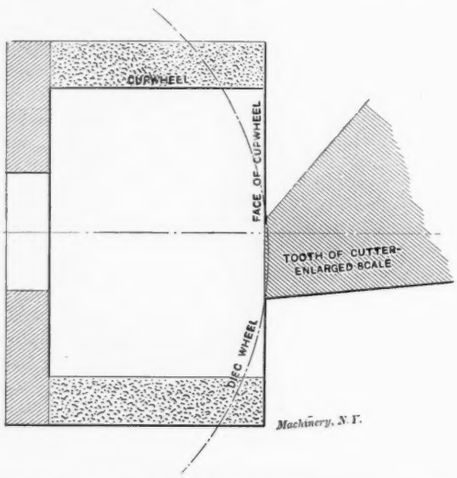


Fig. 5. Effect of Grinding with Disk and with Cup Wheels.

the relief obtained by the cup wheel (the flat relief) is the proper and preferable relief to give to the teeth, as this form will not only strengthen the teeth, but also provide a better cutting edge. The angle of the relief should vary between five

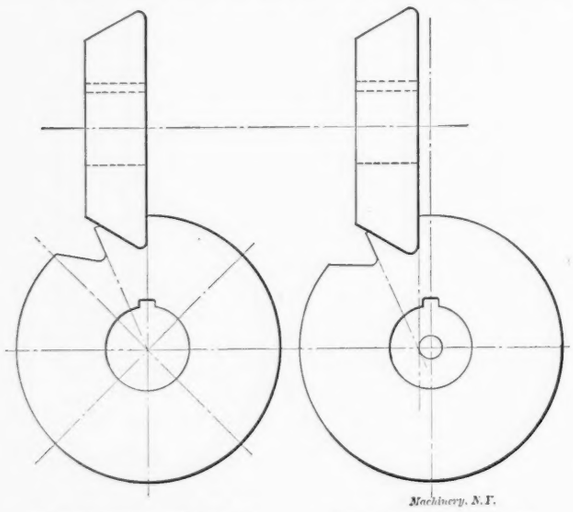


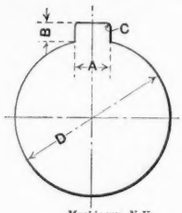
Fig. 6. Cutting Teeth with no Front Rake.

Fig. 7. Cutting Teeth with Front Rake.

and seven degrees. Another thing that always ought to be observed, but which is often overlooked, is that the front face of the tooth should not always be in line with the center of the cutter, but have a certain amount of front rake, the amount of which ought to be governed by the kind of material the cutters are to be used upon and the way in which they are presented to the work. (Figs. 6 and 7.)

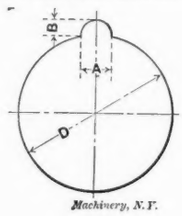
When making plain milling cutters in general, it always ought to be observed that enough metal is allowed between the bottom of the flute and the hole; not, however, forgetting the keyway opposite, where the cutter will naturally be most liable to break. Manufacturers are trying to establish a standard for square as well as half-round keyways which, if adopted by all users, would certainly save much confusion and add to the interchangeability of the cutters. These proposed standards are given in Tables 2 and 3.

TABLE 2. STANDARD KEYWAYS FOR MILLING CUTTERS.—SQUARE.



D = Diam. of Hole.	A = Width of Keyway.	B = Depth of Keyway.	C = Radius of Corners.
$\frac{3}{8}$ to $\frac{9}{16}$ inch.	$\frac{3}{32}$	$\frac{3}{64}$	.020
$\frac{5}{8}$ to $\frac{7}{8}$ "	$\frac{1}{8}$	$\frac{1}{16}$	.030
$\frac{15}{16}$ to $1\frac{1}{8}$ "	$\frac{5}{32}$	$\frac{5}{64}$	.035
$1\frac{3}{16}$ to $1\frac{3}{8}$ "	$\frac{3}{16}$	$\frac{3}{32}$	.040
$1\frac{7}{16}$ to $1\frac{5}{8}$ "	$\frac{1}{4}$	$\frac{1}{8}$	.050
$1\frac{13}{16}$ to 2 "	$\frac{5}{16}$	$\frac{5}{32}$	.060
$2\frac{1}{16}$ to $2\frac{1}{2}$ "	$\frac{3}{8}$	$\frac{3}{16}$	.060
$2\frac{9}{16}$ to 3 "	$\frac{7}{16}$	$\frac{3}{16}$	.060

TABLE 3. STANDARD KEYWAYS FOR MILLING CUTTERS.—HALFROUND



D = Diam. of Hole.	A = Width of Keyway.	B = Depth of Keyway.
$\frac{3}{8}$ to $\frac{5}{8}$ inch.	$\frac{1}{8}$	$\frac{1}{16}$
$\frac{11}{16}$ to $\frac{13}{16}$ "	$\frac{3}{16}$	$\frac{3}{32}$
$\frac{7}{8}$ to $1\frac{3}{16}$ "	$\frac{1}{4}$	$\frac{1}{8}$
$1\frac{1}{4}$ to $1\frac{7}{16}$ "	$\frac{5}{16}$	$\frac{5}{32}$
$1\frac{1}{2}$ to 2 "	$\frac{3}{8}$	$\frac{3}{16}$
$2\frac{1}{16}$ to $2\frac{7}{16}$ "	$\frac{7}{16}$	$\frac{7}{32}$
$2\frac{1}{2}$ to 3 "	$\frac{1}{2}$	$\frac{1}{4}$

Side Milling Cutters.

Next in importance to plain milling cutters, no doubt, are side or straddle milling cutters, the latter name having originated through the use of these cutters in pairs or gangs. These cutters can be considered as a combination of a face milling cutter and an end mill and consequently as far as the face is concerned, whatever has been said about plain milling cutters applies also to side milling cutters. As these cutters are very seldom made of any considerable width of face, they are almost always cut straight.

When milling the teeth on the sides of a side milling cutter, the cutter to use and the angle to which to set over the mill when being cut must be selected with a great degree of judgment and care. It would be almost impossible to give any definite rules or figures, but for guidance, however, it may be said that a cutter of the same form as for milling the teeth on

TABLE 4. NUMBER OF TEETH IN SIDE MILLING CUTTERS.

No. of teeth = 3.1 diam. + 11.

Diameter of Cutter.	Number of Teeth.	Diameter of Cutter.	Number of Teeth.
2	18	$5\frac{1}{2}$	28
$2\frac{1}{4}$	18	6	30
$2\frac{1}{2}$	18	$6\frac{1}{2}$	32
$2\frac{3}{4}$	20	7	32
3	20	$7\frac{1}{2}$	34
$3\frac{1}{2}$	22	8	36
4	24	9	38
$4\frac{1}{2}$	24	10	42
5	26	...	..

the face should be used except that the angle of the cutter should be about 75 degrees instead of 60 degrees. As some readers may be enough interested in the question to wish to get as definite information as possible, and as it is hardly within the scope of this article to go into such close details, the writer would refer those particularly interested to an article by Mr. Porter in MACHINERY for April, 1904.

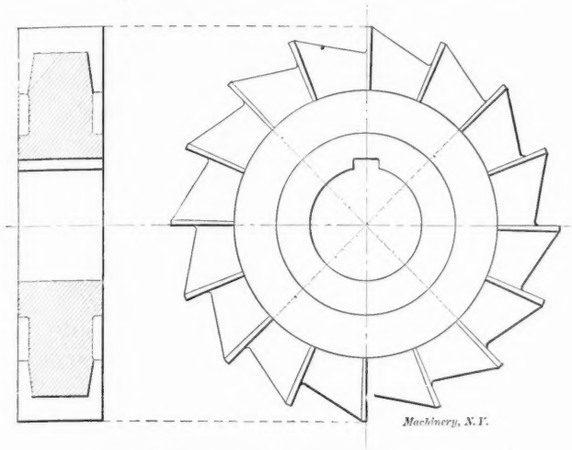


Fig. 8. Cross-section of Side Milling Cutter.

In regard to the number of the teeth, Table 4 gives the number of teeth that straddle milling cutters of different diameters ought to have. The number of teeth is found approximately from the formula

$$N = 3.1D + 11,$$

N indicating the number of teeth and D the diameter of the cutter. What has been said about the relief on plain milling cutters will also apply to the relief on the face of the teeth of straddle milling cutters. The relief on the side of these cutters, however, does not need to be as large as on the face of the teeth. The reason for this is very obvious if one considers the difference in the relationship of the tooth to the surface to be cut, when this tooth is located on a circular and on a plain

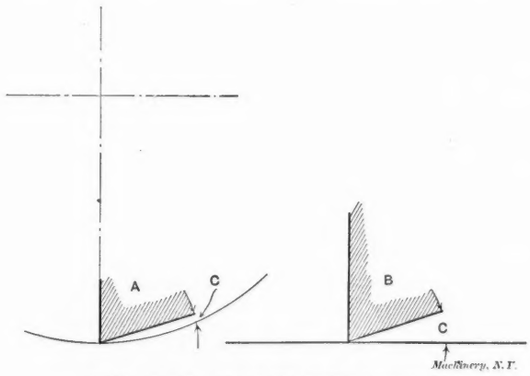


Fig. 9. Peripheral and Side Relief Compared.

surface. Referring to the cut, Fig. 9, where the case is shown in exaggerated scale, it is easily seen that if the same angle of relief is given to the tooth A on a circular surface and to the tooth B on a flat surface (the side of the cutter), the actual relief of C will be considerably larger on the tooth B and will be larger than the relief on the tooth A according to the diameter of the circle on which the tooth A is located. The same angle of relief gives a smaller actual relief C on a smaller diameter than on a large one.

Even not considering this theoretically, there are practical reasons why the relief on the sides does not need to be as large as on the face; in fact, the main reason why a side milling cutter is preferable to a narrow, plain milling cutter for cutting slots is that the former has more chip room on the sides because of having teeth and consequently will permit chip room, thus making the sides of the slot smoother, while, when using the plain milling cutter, the chips will clog between the sides of the cutter and the sides of the slot, producing rough places in the work. Of course, anyone using these cutters will know that the face of a side milling cutter is actually doing all the cutting which is easily seen from the fact that these cutters have to be ground more often on the face than on the sides.

Now someone might infer that no relief on the sides is necessary at all if the teeth on the sides are not doing any actual work. However, there are occasions when these cutters will have to do actual work and that is when no other cutter than a side milling cutter with the teeth relieved on the sides will produce desirable results, as for example, when an absolutely straight slot is required to be cut. When cutting a slot a plain milling cutter will never cut its way straight through the work, because when once out of the straight line it has no means of correcting its path, but must follow the direction in which it started to cut, whereas a straddle milling cutter with its teeth relieved on the sides will, even if started wrong, have an opportunity of correcting its path by being able to cut with its sides. It may be said that if the cutter or cutter arbor is running out, the slot will obviously be wider than the

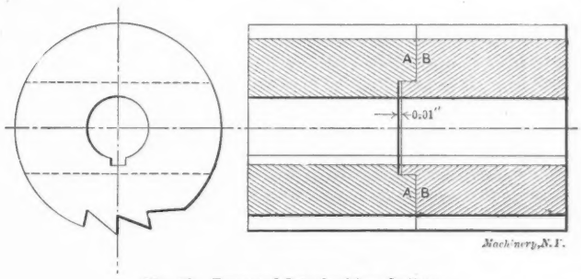


Fig. 10. Tongued Interlocking Cutters.

cutter, but the slot will in all cases be straight. In this connection it is appropriate to mention various ways of making cutters that will maintain standard widths. This is accomplished by interlocking the cutters in such a manner as to permit adjustment when having been reduced in width by grinding on the sides or through wear. There are three different ways of interlocking cutters in common use, viz.: (1) A straight slot through the center across one end of one cutter and a corresponding tongue on one end of the other cutter fitting loosely in the slot. (Fig. 10.) (2) Two or more sectors on one end of each of the two cutters cut away in such a manner that the remaining high sectors in the one cutter fit loosely into the spaces cut away in the other cutter. (Fig. 11.) (3) Opposite every other tooth on one side of each of the two cutters is cut away a portion leaving a space into which the high portions of each of the cutters fit. (Fig. 12.)

Referring to the first kind of interlock mentioned, it must be remarked that this interlock is poorly adapted for maintaining a standard width and is mostly used where cutters of unusual

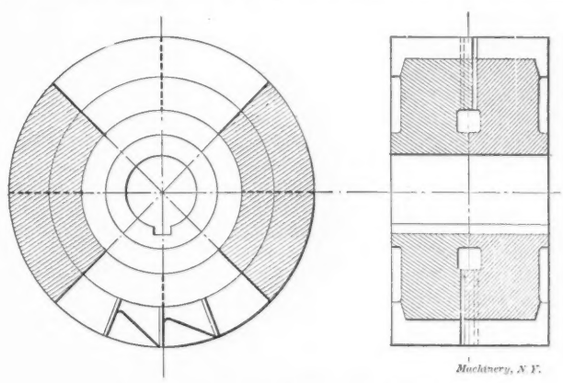


Fig. 11. Cutters with Interlocking Sectors.

lengths are required which would be, if not entirely impossible, at least impractical to make in one piece. This interlock is to be recommended for such purposes because of its being very simple and inexpensive to make. It will be noticed from the cut that there ought to be a clearance of .010 inch between the bottom of the slot in one cutter and the top of the tongue in the other cutter, thus giving a resting surface between the two cutters at A and B, which faces ought

to be ground. It might also be remarked that between the sides of the slot and the tongue there does not need to be a perfect fit and consequently these sides do not need to be ground. As inferred above, this kind of interlock is not to be recommended for maintaining a standard width, although it could be used for such a purpose by inserting thin pieces between the ground faces *A* and *B*. For maintaining a standard width interlocks Figs. 11 and 12 are to be recommended. In these cases the cutters are provided with ground hubs, the width being maintained by inserting thin washers between these hubs. Between the hubs and the interlocking sections of the cutters there should be a recess of sufficient width and depth to permit clearance for milling cutters when milling out sections so as not to cut into the hubs.

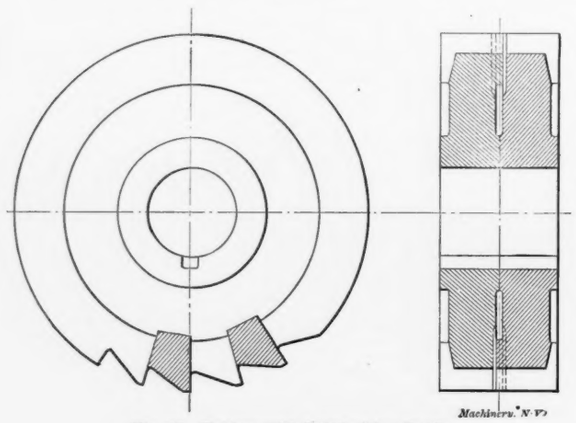


Fig. 12. Cutters with Interlocking Teeth.

There should always be taken into consideration amongst other things what material the cutter is to be used upon. For example, it would not be right to mill a cutter in the same manner and with the same number of teeth for material as widely different as copper and steel. The tables of number of teeth in cutters refer to cutters for steel and cast iron only. Cutters for such materials as brass, bronze, copper, etc., should in all cases be made with coarser teeth and cut with negative front rake. A very important thing to be remembered when milling the teeth of these cutters is that the cutter used for this operation is provided with an ample round between its angular faces so as not to produce a sharp corner in the bottom of the teeth in the cutter to be milled. Through this the liability of the cutters cracking when hardening will be to a great extent eliminated.

* * *

PAPER SCALES.

FRANK B. KLEINHANS.

Although one scarcely sees paper scales used to any great extent, there is nothing made for the use of the draftsman or designer which is more convenient. The scales which are referred to are made similar to the illustration, Fig. 1. The "Universal" brand of paper makes an excellent scale, and can readily be made by any ordinary draftsman. Draw two paral-

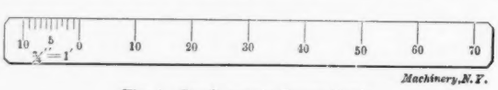


Fig. 1. Draftsman's Paper Scale.

lel lines about ⅝ inch apart for the width of the scale; pencil out the divisions from a standard scale and check up these divisions to be sure that they are correct. A scale about 9 to 12 inches in length is very convenient, although the length can be made to suit one's taste. Having penciled out the scale, and made sure that everything is correct, ink in the divisions with fine sharp lines and print on the figures. Then mark the size of the scale in one corner. After any other information has been printed on the scale, coat the top and the bottom of the scale with white shellac.

It is convenient to have these scales made up for all practicable scales, so one can readily pick out the scale desired; also in drawing out work to different scales, it will be found convenient to use one scale to correspond with the scale of the regular drawing and then another to correspond with the scale of the new drawing.

In taking dimensions from these paper scales with the dividers the following method should be used in order to avoid cutting and marring the divisions. The common method for taking off dimensions from a scale by applying the divider to

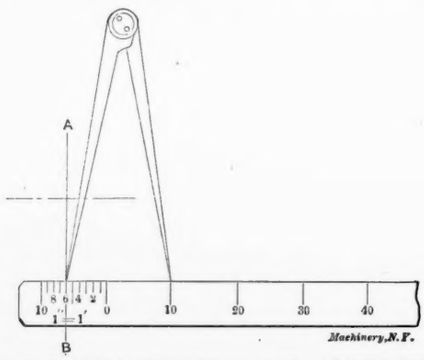


Fig. 2. Transferring Measurements without Injuring Scale.

the scale, soon spoils the divisions, and of course the dividers cannot be set very accurately after this. Fig. 2 shows a quick and easy way of obtaining any dimensions from the scale without touching the scale itself. *A B* represents a line anywhere on the drawing. Let us say that we wish the dividers set to 16 inches. We place the 16-inch mark over the line so as to correspond with the divisions on the scale, and then with one leg of the dividers prick off the distance opposite the dimension shown. We now support the dividers on this leg, remove the paper scale and open up the dividers to the line *A B;* this gives accurate dimensions and of course does not mar the scale. In using the dividers for transferring the dimensions, etc., the joints should be adjusted so that the

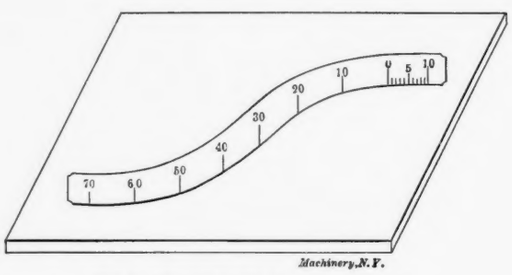


Fig. 3. Measuring the Length of Curves.

dividers will work freely; then by being light on the instrument, very accurate dimensions can be transferred.

Fig. 3 shows another advantage to be obtained by the use of paper scales. In figuring weights one must often obtain the length of irregular curved lines. The scale can be bent to conform to the neutral line of the curve, and thus the length can readily be obtained. Another advantage in the use of the paper scale is shown in Fig. 4. There is scarcely a time when the drawing board does not have several triangles, T-squares, lead pencils, drawing instruments, etc., scattered all over it. To use an ordinary wood or metallic scale on such a board is to clean everything out of the way. The convenience with which a paper scale can be used on similar circumstances is shown in Fig. 4.

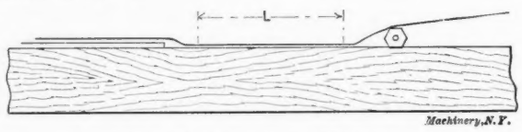


Fig. 4. The Advantages of Fexibility.

In reference to the divisions, many factories are now adopting scales up to 100 inches, and a scale divided into tenths has all the advantages of the decimal system. The last division is the only one that needs to be subdivided into inches. Of course this scale can also be divided into feet and inches as well as being divided into decimals as shown.

THE MACHINE SHOPS OF PRATT INSTITUTE.

There are at least two ways of regarding the function of the machine shop in technical training. From one point of view it is a "shop" in the strictest sense, where the student is taught the principles of an already well developed art—the art of making machine parts and assembling them into the finished product with commercial accuracy and speed. On the other hand, the student may be taught to approach the lathe or planer as he does the testing machine, not to learn how to perform the greatest number of operations in a given time with the required degree of accuracy, but to learn the properties of the various materials used in construction and the laws which determine their action when subjected to various stresses.

This latter idea can obviously be applied only to the training of the engineer, the man who is being fitted, in part at least, for a career of research and original investigation. Instead of a "shop" then, we would have a "laboratory," and some schools have actually made this change in name, feeling doubtless that it expressed their ideals better than does the simpler word. In practice, however, it is doubtful if this ideal can be very closely approached; such work as that done by Dr. Nicolson and the students of the Manchester Technical School, in investigating the action of cutting tools of high-speed steels and other work of this character, would properly come under the classification of laboratory work; but there is no school which can offer the time and facilities for giving the whole student body a thorough course in work of this kind, nor perhaps would it be advisable if it were possible, since the test of the future engineer's worth will be in a large measure his ability to produce commercial results with commercial means, and the knowledge of machine shop practice as an established art must necessarily form an important part in the training of a man who expects to be concerned with the business of working metals into useful forms. Whether, then, this part of the school equipment be called a "shop" or be dignified by the term of "laboratory," the course of instruction tends more or less in the same direction; the student is taught how best to drill a hole, to cut a thread, to set up work on the planer and milling machine, and to shape, harden and temper the tools used in metal working.

The Pratt Institute of Brooklyn holds, as its main object, the helping of young men and women to a higher industrial plane. This object is accomplished through day and evening classes in electrical and mechanical engineering, chemistry, art, design, social science, and many other lines where it has been demonstrated that practical instruction can be given to young men and women. With this end in view it is natural that the shop curriculum should have developed along the line of the more practical of the two tendencies discussed above, and that the equipment should be so selected and arranged as to give the best possible commercial training to the student. In the following paragraphs the writer aims to describe the equipment of these shops and the methods of instruction therein pursued, believing that such a description will be of interest to those who feel their need of more systematic training in machine shop practice, as well as to instructors actually engaged in teaching this subject.

Fig. 1. The Evening Class in Machine Shop Practice, at Pratt Institute, Brooklyn.

The shops, in their present location and in over fifty per cent of their equipment, are new. They occupy two floors of an ell of the Technology Building, comprising altogether, with the office and tool room extensions in the main building, a space of about 12,000 square feet. The rooms are lofty, neatly painted in light colors, and furnished with windows on three sides and a part of the fourth. The artificial lighting is by arc lamps on the indirect reflected plan, as may be seen in the interior views Figs. 2 and 6 inclusive. Fig. 2 is a view taken on the lower floor looking down the room from the tool room end. Fig. 3 shows a view of this same room looking in an opposite direction. In Figs. 2 and 4, which are taken from the tool room end, the superior character of the machine tool equipment will be appreciated. At this end of the room are grouped three Bath grinders, a Cincinnati drill press, Bickford radial drill, Colburn boring mill, Espen-Lucas boring machine, a No. 3 Universal milling machine of the Garvin design, and a number of shapers and planers of various capacities up to 30 x 30 x 8 foot capacity. These tools are all of the most modern design. There are two enclosures at

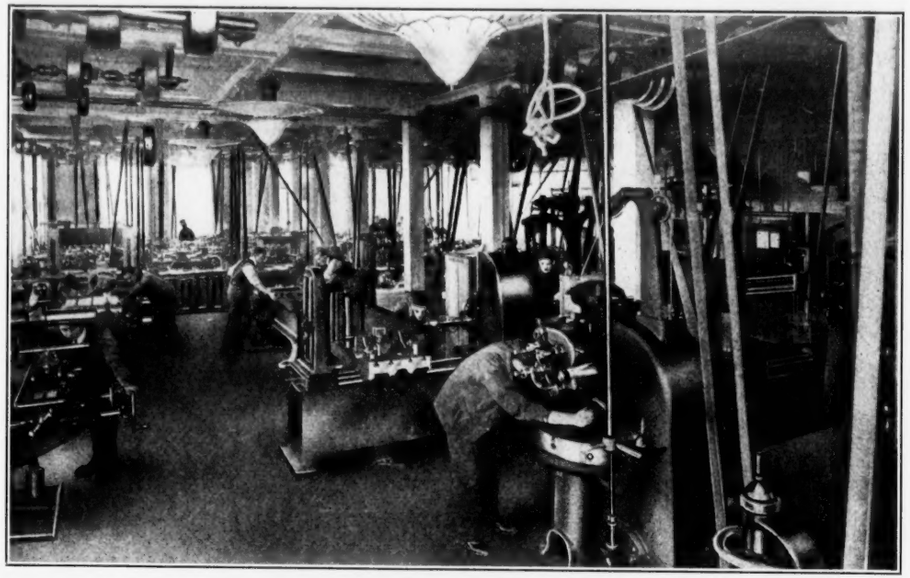


Fig 2. The Large Tools on the Lower Floor.

Fig. 3. The Filing and Chipping Benches.

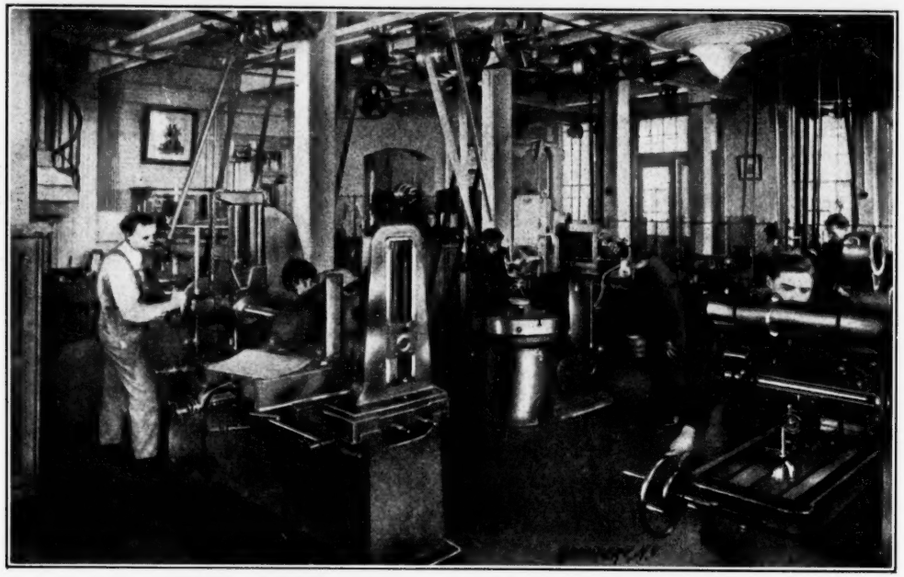


Fig. 4. Looking toward the Tool and Assembling Room in Shop No. 1.

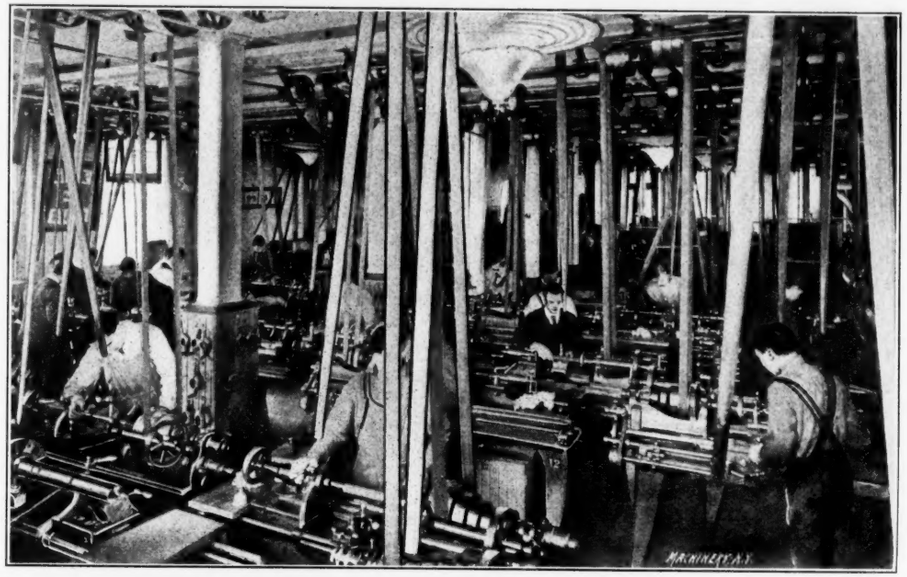


Fig. 5. The Lathe Department in Shop No. 1.

this end of the room; one of them is the assembling room, containing a universal milling machine, lathe, etc., and is devoted to tool making and the fitting and assembling of machine parts; on the other side in the tool room proper are stored the drills, milling cutters, arbors, etc., as well as the materials for the various exercises, all to be given out on check as required.

The center of the room is occupied by the lathe department. Most of these tools are also new, and include machines of the latest types with quick change gear devices, and of special design for working with high-speed steel. A group of speed lathes for the early lathe exercises and for other practical

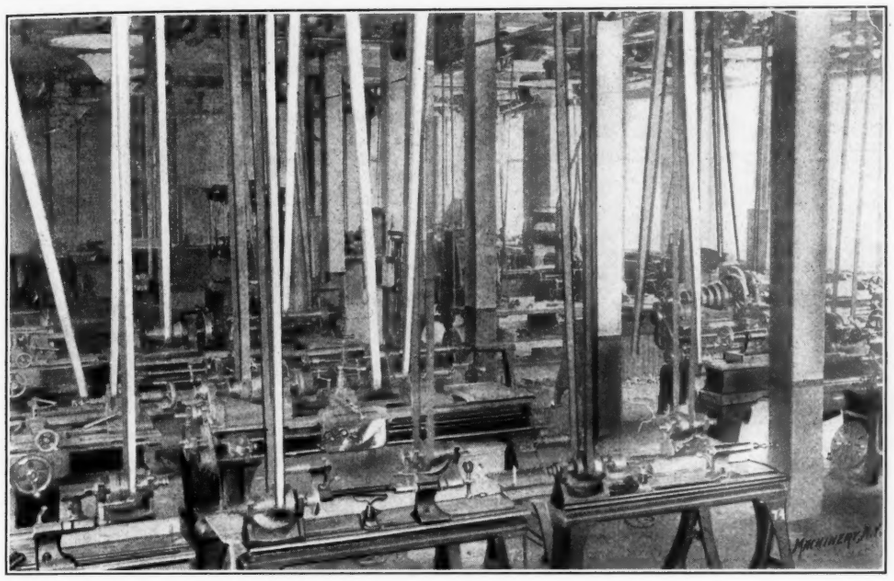


Fig. 6. A Part of the Lathe and Planer Equipment of Shop No. 2.

uses is located at the extreme end of the room as shown in Fig. 3. The filing and chipping benches are provided with screens to protect the student from the flying chips of their opposite neighbors. At one side of the room is the hardening and tempering outfit shown in Fig. 8. This comprises an open and muffle furnace, a melting pot, blow pipe table, and an oil bath, with a pressure blower and reservoir for furnishing the blast.

The upper floor also has its own tool room, with the offices of Mr. Kaup, the principal of the department, adjoining it. A view of this floor is shown in Fig. 6. There are a large number of engine lathes, speed lathes, drill presses, planers, shapers, etc., and a complete outfit of tools for use with them. There are a number of noticeable conveniences in this room and in the room downstairs as well. Wherever it is possible to put a blackboard so that it will not interfere with any of the machines, this has been done. In some cases where a blackboard was desired and was not otherwise obtainable, it has been hung on hinges to fold against the wall, opening up across one of the windows when in use. Each lathe has such wrenches and attachments provided for it as are necessary to facilitate the getting out of its work. Boards with hooks for dogs are distributed around the room and it is required that the dogs be brought back to their proper places after they have been used. The planers, shapers, milling machines and other larger tools each have their own cupboards where the various appliances necessary for their operation are kept. Cupboards are, in fact, put around the walls wherever there happens to be nothing else, the idea being to furnish all the necessary conveniences, and a place for keeping each of them as well, and the student is made to live up to the requirement that each tool shall be returned to its proper place after using. Both shops are driven by motors which receive their current from the main power plant of the school.

In the beginning of his shop work, with the first exercise, the student is taught the meaning and purpose of every movement of his body and every point in the design of the tool he uses. He is given a block of cast iron whose edges he is to bevel with a cold chisel. Mimeographed sheets of instruction are given him. In these the various shapes of chisels are described, particular attention given to the cutting angle, the shape of the stock from which it is forged, the size of the stock, and length of the chisel and the way in which it is to be held by the operator; then he is told how to grind the various forms and the proper way of holding the work. Each move is described in turn: the chalking of the rough surface, scribing of the guiding lines, and every other practical point that the experience of the instructor can suggest. The question of the proper weight of hammer and length of handle is discussed, and reasons given for choosing the weight and shape supplied to the student. The whole operation is in fact analyzed in much the same way as is done under the Taylor system of shop management, the student in these preliminary exercises being required to follow a method of procedure laid down by men experienced in the art. Furthermore, from the very start no time is wasted on useless work. The blocks whose corners are beveled in the first exercise are cast with a monogram on the top surface and are afterward finished as paper weights for use in the school; thus, instead of being merely a mechanical exercise, the work arrives at once at the dignity of productive labor. After two exercises in chipping, which are repeated by each student until he has been able to perform work in a satisfactory way, similar minute instructions are given in the art of filing; the various tools, ways of holding work, the proper way to grasp the file, and the proper movement of the arms, are all detailed, together with much useful information as to the relative value of different grades of files for different work. Scraping, planer work, turning, boring, milling, and more complicated operations are taken up in turn. In each case, in the earlier part of the student's course, he is required to follow a set method of procedure, being given definite instructions in speeds, feeds, tool grinding, and holding the work. This information is all

Fig. 7. The Hardening and Tempering Plant.

the result of direct experiments on the part of the instructors, checked by their practical commercial experience.

After this rigid preparatory course in the fundamentals of the art is completed, the student is allowed more latitude. As previously intimated a point is made of spending all the energy of the shop in productive labor exclusively. When the student has learned to handle the various tools and machines, he begins to work on any of the simpler appliances that are constantly being turned out. The larger part of the apparatus

in use in the school has been and is being made by the school shop. Constant repairs are called for, and with the growth of the institution, large quantities of new instruments are required. Students often have work of their own which they desire done, such as small motors, gas engines, or light machinery of various kinds, and in the near future simple machine tools will be built for sale in the open market.

The student is also at once introduced to something approaching the routine of shop management and system. All his time is accounted for, the tools he uses from the tool room are charged to him, the cost of the materials and labor he puts into his work is recorded, and he is put under the supervision of foremen taken from the older and more capable members of the class, who are thus given an opportunity to develop in executive ability. As time goes on, the student is finally left more or less to himself, so that the instructor has means of judging as to his capability for independent work.

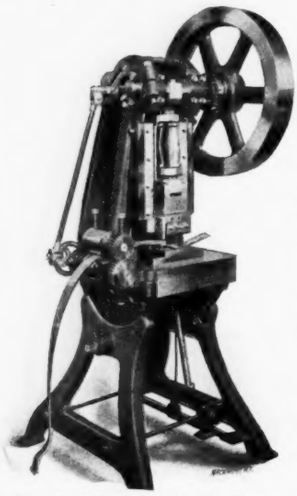


Fig. 8. A Press Built in the Shops.

Perhaps an enumeration of some of the work done by the more advanced classes will give an idea of the measure of success attained under the system of instruction pursued. Most of the small tools, such as reamers, milling cutters, taps, tap wrenches, etc., are made in the shops as fast as they are needed. The building of scientific apparatus for the various departments has already been mentioned. Such things as testing machines, micrometer calipers, microscope mountings, electric motors and dynamos, are supplied to other departments. Fig. 9 will give an idea of the die work attempted. Near the front of the group will be seen the dies used for making the brass checks used in the tool room; towards the right are some thumb tacks and the tools used for making them; at the rear of the group are the rotor and stator punchings for an induction motor, and the dies with which they were punched. The press in which this work was done, shown in Fig. 8, was built entirely by the students from patterns and

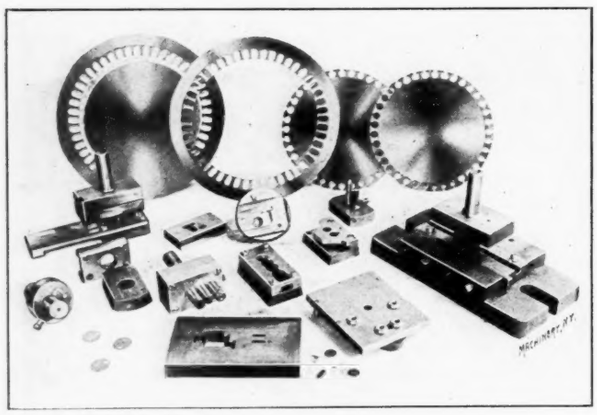


Fig. 9. Examples of Die Work done by Students.

drawings furnished by the E. W. Bliss Co. The No. 3 universal milling machine with full automatic feeds before referred to was built in the shops. Among other machines so constructed are: two turret heads; a twenty inch crank shaper; two double spindle drill presses; two tool grinders; and two 5-horse power motors. In a sense the shop may be said to be self supporting, since the product would cost, if purchased in the open market, considerably more than the raw material used and the supervision required in its production.

There are in general three classes of students who make use of the shops. The regular day classes in mechanical and electrical engineering require, the one ten hours a week for two years, and the other ten hours a week for one year in the shops. There is also directly under the supervision of Mr. Kaup, a class in machine construction and design which aims to fit the student for the position of machine designer. This takes up in turn the principles of mechanical drawing, pattern making, molding, forge work, and machine shop practice, and finally the commercial design of machinery. In this latter subject the students are allowed considerable latitude of judgment, subject to the criticism of their more experienced teachers. They can follow their work through all the stages of pattern shop, foundry and machine shop and thus get a good training in directions in which many draftsmen are deficient. Such of this machinery as possesses sufficient merit is to be manufactured and sold.

There is a third class, perhaps the most interesting of all, which meets evenings on three nights of the week. It is composed of young men who, unlike the students in the other classes, are unable to give up the daylight hours to advanced scientific study. Fig. 1, taken in the old shop, shows a group of these men. Mr. Kaup, who stands in the front at the left side of the picture, realizing that the product of the school shop is after all men, and not machinery, takes more pride in this group than in all the presses, milling machines and shapers the shops have ever built. The students are mostly engaged during the day as lathe or planer hands, or in doing other machine shop work, but many of them have never had the opportunity to get a broad and comprehensive view of the whole subject of machine shop practice. The definite instruction given them by lectures and exercises in these evening classes fits them for higher pay as workmen, and helps many of them to positions of greater responsibility. This class seems to fill a great need in this day of specialized operations, when a workman is kept doing the thing he is used to and given little chance to learn about the business as a whole. Many former students are able to trace their first steps in the upward climb to the stimulus given by the evening classes of the institute. It is an altogether inspiring sight to pass the school building on a class night and see them lighted up from the ground to the topmost story, the rooms filled with young men and women in this or other courses who are preparing themselves for greater opportunities and greater rewards than come from the occupations and stations in life they now occupy.

* * *

Notwithstanding the fact that the water composing the waves of the sea has little progressive motion, except where shallow, the popular impression is that it travels with great rapidity, and this impression is apparently confirmed by such catastrophes as occurred last October to the Cunard steamer *Campania*, the lower deck of which was washed by a "giant" wave causing the loss of five steerage passengers and the serious injury of many more. But, upon second thought, it is not surprising that tons of water, shipped by a vessel making, say, twenty miles an hour, should cause great damage and hurl human beings about like chips. The property of inertia is shared by water the same as other substances, and when a vessel lurches so that a large roller dashes water up on its decks it does not instantly acquire the speed of the vessel but is rapidly left behind, washing the decks clear of everything portable as it approaches the stern.

* * *

The persistent manner in which certain bits of information flit through the columns of trade papers reminds one of the farewell tours of certain noted actresses—they are always going, but never gone. As an example we might mention the old and very well-known trick of cutting off a gage glass without tools other than a common match which is used to mark a ring around the inside of the glass and to heat the exterior until it cracks off. When we consider the many things that are useful to the engineer or machinist but of which we never hear anything outside the shop it seems that the energies of technical papers are too often wasted in repeating such notes. On the other hand the crop of younger readers find these things new so what are we to do about it?

SIMPLE MECHANICAL DEVICES FOR REDUCING THE COST OF LABOR ON MACHINE WORK.

OSCAR E. PERRIGO.

In the presentation of mechanical devices in the pages of technical papers and magazines a noticeable feature frequently seems to be to describe and illustrate something absolutely new; something that nobody ever heard of or dreamed of, or ever would have thought of if this particular mechanic had not favored the earth with his presence at this particular time. So much does this idea often possess the mind of budding mechanical genius that the prosey, everyday, practical usefulness and consequent financial value of a device is either considerably obscured or lost sight of altogether.

Quite recently a prominent technical journal published an engraving and description of a small hand device as one of these exceedingly new and simple mechanical devices that was such a valuable addition to mechanical science that it seemed a pity no one had ever conceived of its application before. In this case the device *was* practical, valuable and useful. But it was not *new*. The writer well remembers working many weary days with it the first year of his experience in the machine shop, lo, these many moons gone by.

Another device is shown which must have been evolved by the active brain of a scientific mechanic for all its parts seem to be calculated with extreme accuracy and designed strictly according to the book, and its construction carefully following the lines laid down. It would undoubtedly do the work for which it was designed. But the expense attending its construction, the narrow limit of its application and the infrequent necessity for the use of such a device made it a financial failure.

The truly successful device, mechanically and financially, is not always, or often, the one of carefully scientific and elaborate design or intricate construction. It is more often the one of few parts, designed on well-known mechanical principles, plainly constructed, strong and durable and that *does the work quickly, correctly and economically*—that "delivers the goods." The fact that its principles are old, that this piece or that has been used long ago, or that someone else could have made it just as well, and all similar considerations don't count for much with the man who has to pay the bills. What he wants first, last and always is *results*. As to how they are brought about is a secondary matter.

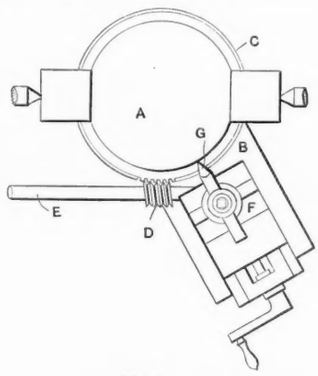


Fig. 1.

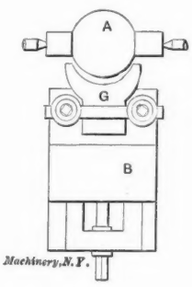


Fig. 2.

Two Methods of Finishing Spherical Castings.

To illustrate these facts and the results that come from simple mechanical devices, designed to meet real and practical conditions, the following devices and attachments that have been designed, built and successfully used, are presented as examples.

Referring to the engravings, Fig. 1 shows an attachment for turning the surface of spherical pieces *A*, of cast iron. A large number of these of varying diameters was required. The attachment designed for the work is here shown. It consisted of a worm gear *C*, in the form of a ring attached to the base of the compound rest *B*, of an ordinary engine lathe. Engaged in the worm gear was the worm *D*, which was operated by proper gearing, through the medium of the shaft *E*, the bolts securing the compound rest having been slightly loosened to permit it to rotate and yet tight enough to hold it firmly and prevent any chattering of the tool. In the tool block *F*, was fitted the tool *G*, which could thus be adjusted at the proper distance from the center of rotation, which was directly beneath the center of the spherical piece to be turned, so that any diameter of sphere could be turned, the tool being carried around the surface by the worm gear feed. This was a great improvement over the former method of roughing off the casting by a tool in the compound rest, operated by the hand feed and then hand-tooling to a templet. The device had its limitations and the smaller spheres were not so economically turned as the larger ones.

In consequence of this the very simple device of a "forming tool" was resorted to and arranged as shown in Fig. 2, in which *A* is the piece to be turned, *G*, a forming tool shaped exactly to the curve required and held in the tool block *B*, as shown. A different tool was, of course, made for each different diameter of sphere.

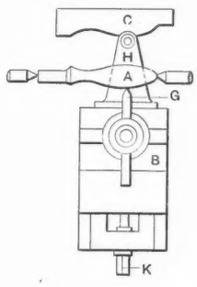


Fig. 3.

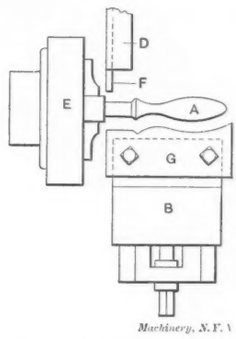


Fig. 4.

Improvements in the Manufacture of Crank Handles.

The results were as follows: A sphere that would take from two to three hours to turn by the old methods, even with an expert man to hand-tool it, could be made in less than an hour by the device shown in Fig. 1, and the workmanship was much better. The device shown in Fig. 2 would finish any piece within its range in less than half an hour. The advantage of the special device is apparent and the reduction of cost easy to calculate. The device shown in Fig. 1 was later used in turning the concave and convex surfaces of step bearings for turbine water wheels, some of which were sixteen inches in diameter.

A large number of drop-forged steel handles, such as shown at *A*, Fig. 3, were to be made. The previous plan was to make a "former" *C*, having the exact contour of the handle *A*. Against this was a friction roll, pivoted upon the tool block *B*, as shown. The feed screw *K*, having been removed, the tool block *B*, could be forced forward by means of a cord and weight so as to keep the friction roll always in close contact with the former *C*, and in consequence the proper curve was made on the handle *A*, as the lathe carriage moved laterally from right to left. The workmanship was fairly good but the device was only capable of finishing drop-forged pieces that were forged nearly to the finished size.

A more expeditious method of making these handles was demanded and here again a forming tool came into use. Instead of using a drop-forged blank the handles were formed from a round bar of steel held in the chuck *E*, and the forming tool *G*, secured to the tool block *B*, by the two screws as shown, was fed against it very slowly until the entire contour was formed, when it was cut off from the bar by the cutting-off tool *F*, held in the stock *D*, moving forward from the back of the lathe. A steady-rest of proper form supported the piece at its largest part to prevent vibration as it was being turned. The results were: Very smooth work, the cost of drop forging entirely eliminated, and with the addition of an automatic feed one man could run any number of machines up to ten, while by the old process he could not properly handle more than two. As will be seen, the device was economical to construct and not liable to get out of order.

It is the practice at the present time to turn up short shafts with the various shoulders and different diameters as well as lengths in a turret lathe, the cutting tools being of a kind technically denominated "box tools." There are, however,

many of these shafts that are too long to be well handled in the usual turret lathes, and there are many shops that do not possess even the ordinary make of turret lathes. Hence these shafts must be cut from the bar in a cutting-off machine, centered and turned up in an ordinary engine lathe. Where there are several different lengths and diameters as shown on the shaft marked *A*, in Fig. 5, it is customary to set a stop for a single diameter, and another for the length up to one shoulder, and then turn up that one shoulder on all the shafts. Then the stops are set for the next shoulder and they are all handled over again, and so on until the job is completed. This is a long and laborious process, which might be much more economically performed if *all* the shoulders on one end, for instance, could be turned up without changing the tool or removing the shaft from the lathe. Figs. 5 and 6 show how one young machinist did this, and by doing the work "by the piece," more than doubled his weekly pay.

Fig. 5 is a plan of a portion of the carriage lathe *C*, the tool block *B*, and an ordinary thread gage *D*, of an engine lathe; while the same parts are represented in front elevation in Fig. 6. The thread gage *D* is a piece clamped upon the dove-tail of the carriage as a stop for the thumb nut *d*, on the gage screw, *e*, which is fixed to the tool block *B*. By its use any one diameter may be turned with fairly accurate results. To obtain several diameters the pivoted gages *H*, *J*, *K*, are attached to it. These gages are made the exact thickness necessary to suit the variations in diameter of the finished shaft, and by folding one, two or three of them down between the nut *d*, and the thread gage clamp *D*, the tool *G* is stopped in the proper positions to correctly form the different diameters.

In the same manner the gage levers *m*, *n*, *p*, are pivoted to the clamp *Q*, fixed to the V's of the lathe, *R*, and by being brought down to a horizontal position will give the proper stops for the various lengths of the shaft from shoulder to shoulder.

The device is very simple in construction and use and by it the three shoulders and three diameters were turned without

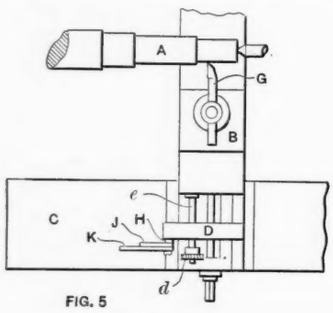


FIG. 5

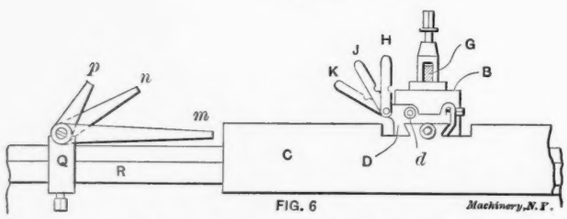


FIG. 6 *Machinery, N.Y.*

A Device for Turning Shouldered Shafts.

removing the shaft from the lathe. Four or five different dimensions could have been handled just as easily. The practical utility of the device is proven by the facts that the piecework price was 25 per cent lower than those produced by day work and yet the workman more than doubled his day pay. The machine capacity was therefore between two and a half and three times its former capacity, hence the machine rate per hundred pieces was very much reduced.

Another instance of reducing the cost by the addition of a mechanical device for that purpose is shown in the diagrams in Figs. 7 and 8. This was a case of cutting the teeth or "hobbing out" large bronze worm gears. It is well known that bronze is a very stubborn metal to cut, whether with a drill, planer, milling machine or gear cutter. In this case the wheels were about three feet in diameter and the pitch coarse, about four inch, and cut with a hob eight inches in diameter, hence great driving power was required. The original driving power of the hobbing machine is shown in Fig. 7, in which a gear *C*, of 96 teeth was fixed on the shaft carrying the "hob," engaging with a pinion *D*, of 24 teeth on the second shaft, upon which was a 20-inch pulley *E*, with a 4-inch face. The gearing ratio was, therefore, only four to one. The cutting was very slow and tedious as a very fine feed must be used owing to a lack of driving power. An improvement was determined upon. The pulley *E* was replaced by a gear *F*, of 120 teeth, engaging a pinion *G*, of 20 teeth which was mounted upon a new shaft upon which was also fixed the 20-inch pulley *E*, as shown in Fig. 8. This gave an additional ratio of 6, which, multiplied by the original ratio of 4 gave a driving power ratio of 24, instead of 4. It required nearly three weeks to "hob out" one of the worm gears as the machine was constructed (the

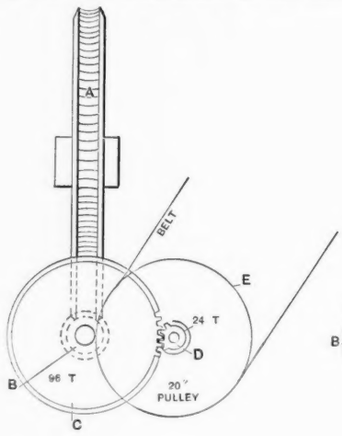
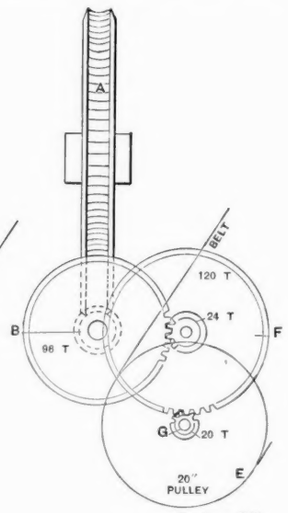


Fig. 7.



Machinery, N.Y.

Fig. 8.

A Change in Gearing to give Increased Power.

teeth were cut entirely from a solid blank) while with the improvement added the work could be done in four days, and the work was of a much higher grade, being much smoother and more accurate. Thus the cost was reduced to about 22 per cent of the original amount.

Many more similar examples might be given showing that it is often a simple matter to reduce the cost, and frequently to produce better work, by the addition of an economically constructed and easily operated device to the machine upon which the work is being done, and these will be vastly more appreciated by the management than the more elaborate and expensive, even if more scientific, devices sometimes seen in some of the shops that pride themselves on being strictly "up-to-date."

* * *

The development of machine tools, of course, naturally results in the improvement of one class of machines reacting upon the others. The features of design which have increased the output of a boring mill, for example, will to some degree apply in other machines, but designers are conservative in adopting such hints oftentimes. For instance, none of them, so far as we know, has apparently heeded the fact that the circular track, which is now considered practically indispensable for the boring mill table to support it rigidly under the thrust of heavy cuts, would be of almost equal value for lathes used for heavy faceplate work. It is obvious that the conditions are largely identical and it would seem that the boring mill construction would work for improvement in stiffness of the headstock support. Driving wheel lathes are common examples of tools which would be materially stiffened by such construction.

* * *

The Truesdale coal breaker of the Lackawanna Coal Co., at Scranton, Pa., is said to be the largest in existence, being 128 feet wide, 158 feet long, and 171 feet high. All the machinery is electrically operated and the slate is said to be mechanically separated. Its capacity is 6,000 tons per day.

THE SUCCESSFUL APPRENTICESHIP AND EDUCATIONAL SYSTEM OF THE GENERAL ELECTRIC CO., WEST LYNN, MASS.

The Thomson-Houston Electric Co., West Lynn, Mass.—a part of the General Electric Company—organized in 1902 an apprenticeship system under which boys are indentured as apprentices for a period of four years. The boys not only receive a regular shop apprenticeship course of instruction during this time, but also have a course of school training during working hours, amounting to two and one-half hours two days a week, forty weeks a year, for three years. Apprentices are paid by the hour, including time spent in the school room. Grammar school graduates receiving 6c. per hour for the first six months; high school graduates 8c. per hour for the same period, and thereafter all the branches are advanced 2c. per hour at the end of each six months.

The system of training at these works is one of the most successful and perhaps the most completely worked out of any in the country. It has been developed by Mr. M. W. Alexander, an engineer of the General Electric Co., and is under his immediate supervision. An address by Mr. Alexander recently published in the *National Civic Federation Review* fully describes the system and contains so many practical points of interest and so many suggestions for the instruction of mechanics that we reproduce it nearly in full.

In developing our apprenticeship system we recognized the necessity for educational development of the boys and incorporated into the system a school especially fitted for the needs of our apprentices. The lack of proper educational opportunities in the evening in the city of Lynn, such as, for instance, the city of Philadelphia offers in the Spring Garden Institute, was one reason which prompted our company to start its own school. The other reason was the desire to give to the boys eminently practical knowledge of the very kind which they will need later on as journeymen and foremen. We therefore selected our own engineers, draftsmen and shop foremen as teachers. These men know the needs of our factory and can impart to the boys the specific knowledge which they require in our own factory and, in a general way, in any manufacturing establishment of a similar character.

The school first met in the evening, when the factory closed; the boys assembled in the school rooms, partook of a light lunch furnished free of charge by the company and received instruction for about two hours. It soon became apparent that after a day's work the boys were too tired to reap the full benefit of the school instruction, and the evening school was therefore changed to a morning school. The blowing of the factory whistle in the morning is now the signal for the commencement of the school. The boys come to the school room physically and mentally rested. Formerly we had difficulty in keeping the apprentices in the school; now we rather experience difficulty in getting them out of the school room into the shop.

Theoretical Instruction.

Each boy receives three years of instruction. He enters school after he has been an apprentice for about six months and he graduates from the school several months before he graduates from his apprenticeship. Each school year consists of forty weeks with two sessions of two and one-half hours each week. The comparatively small amount of time devoted to instruction does not permit us to go very deeply into the various subjects which we teach. In fact, a large part of the teaching is merely a review of some of the grammar school work, but applied to practical factory conditions. Experience has prompted us to devote a good share of the time to this review and to carry it back to the elementary stage of the subjects which we desire to review. The rest of the time at our disposal is devoted to subjects which either have not been taught in the grammar school at all or have been touched upon only in a general way. An important aim in our review of grammar school subjects is to bestow upon the boy additional knowledge by giving him an insight into technology.

During the first year we teach English and mathematics, devoting one-third of the time to the former and two-thirds to the latter. In English, the spelling of technical terms is first taken up and then followed by short dictations explaining technical processes, describing materials and their properties and various kinds of apparatus. The boy, therefore, becomes acquainted in a general way with all our practical work.

Mathematics is the second subject which we review during the first year. We start with simple processes of addition, subtraction, multiplication and division, first of whole numbers and then of decimal and common fractions, finishing the year with proportion and percentage calculations. Alternating with arithmetic, we review mensuration.

Only concrete examples are given by the teachers, who as stated before, must aim to lead the boy on to independent thinking and to make him acquainted with the very technical arithmetic which he may have to use as a shop foreman. It is only a test of the boy's memory if you ask him to solve "$3 \times 420 \times 12$," but it is an entirely different test if you put the same problem in the following manner: "A factory consists of three rooms; each room is lighted with twelve arc lamps, each of which requires 420 watts of energy. How much horse power of energy will have to be provided for the lighting of the whole factory if 746 watts equal one horse power?" In stating such a problem, we explain in the very briefest manner the meaning of "watt" as a unit of measurement of energy, and we also explain briefly the nature of an arc lamp, showing the outside appearance of the same, and the inside mechanism. In fact, whenever a teacher speaks of a piece of apparatus or a part thereof, I insist upon having such apparatus or part shown to the boys, if this is at all possible. The boys will associate the picture with the name of the apparatus and will therefore retain the name better in their memory. I do not expect that the boy will learn fully the meaning of a watt of energy, or a volt of pressure, or an ampere of current, or for that matter, the operation of an arc lamp, the characteristics of an incandescent lamp, or the principles that govern the running of a motor. The terms "watt," "volt" and "ampere," "arc lamp," "incandescent lamp" and "motor" will become, however, familiar to him by frequent usage, and when, later on in the teaching of physics and magnetism and electricity, these same terms are brought before him again, they will appear to him as old acquaintances and will therefore make their study so much easier to him.

I desire to give one more illustration, taking this time mensuration as my subject. A problem may be commonly stated as follows: What is the weight of a steel rod one-half inch in diameter and fifty inches long? We state the problem in a different manner: "The machine shop is ordered to produce seventy-five steel pins, each to be one-half inch in diameter and three-quarters of an inch long. These pins are to be cut from a long steel rod and the tool for cutting off the pins will waste one-sixteenth of an inch of material between each two pins. How long a steel rod will be required, and what will be the weight of the same?" This is a problem which we meet in everyday factory life and which involves nothing else than plain multiplication and addition. It is simply a question of multiplying 75, the number of pins, by ¾ inch, the length of each pin, and adding to it 74 x 1-16 inch, which we have wasted by the cutting-off tool. The whole will give the length of steel rod required. Now this length is multiplied by the area of a half-inch circle to obtain the cubical contents, which, when multiplied by the specific gravity of steel (a figure which we give to the boy) will give the total weight.

During the first part of the second year, two-thirds of the time is devoted to square and cube roots applied to practical problems and to calculations of weights of different materials and machines. The remaining one-third is devoted to English.

We teach the boy to write "shop notes," by which I mean that we teach him to express himself in a very brief and clear manner and without flourish and frills. To illustrate: if a boy should be unable to finish a piece of work because his machine is worn out and, therefore, cannot be run at the proper speed, I expect him to notify the superintendent of this fact immediately—nothing else than what we would expect of any proper shop foreman. His note should, perhaps, be as follows:

I. F. Baker, Supt.:

I shall be unable to finish the 20 motor shafts by next Friday as promised, because my lathe is in very poor condition and cannot, therefore, be run at the proper speed. I expect to finish the shafts by Monday of next week.

(Signed) N. M. Smith.

It is not necessary for the boy to start the letter with "Dear Sir." The superintendent knows how "dear" he is to the right boy without being reminded of it. It is a waste of time for the boy to write and for the superintendent to read a letter like the following:

I. F. Baker, Supt.:
I am extremely sorry to report that I shall not be able to fulfil the promise which I made you a few days ago in regard to the twenty motor shafts which I expected to finish by Friday of this week. The lathe on which I am turning these shafts is in very poor condition. I cannot, under the circumstances, turn out as fast work as I could if my machine could be run at a higher speed. I shall endeavor to finish these shafts by Monday of next week and hope that this delay will not cause you any inconvenience.

I remain, yours very truly,
(Signed) N. M. Smith.

Many a good shop foreman impairs his usefulness in a position of responsibility because he cannot write a correct and concise letter.

During the second part of the second year, English has been dropped entirely, and mathematics is only pursued on alternate mornings; the other mornings are taken up with physics with particular reference to mechanics.

During the third year, one morning per week is devoted to mechanical drafting, the other mornings to mechanics and mechanism, magnetism and electricity. Again we pursue the policy of speaking in concrete terms and illustrating these terms by the objects of which we speak. Our whole factory is utilized as a laboratory which not only aids in the proper understanding of the subject matter, but also arouses and keeps awake the interest of the boys. Mechanical drawing does not aim at the designing of machinery, but rather at the designing of the tools which journeymen need in the process of manufacturing machinery. We give, for instance, to the apprentice the cover of an arc lamp which has nine holes of different sizes and ask him to sketch a jig or holder by means of which these different holes can be drilled by a machine accurately and quickly without the necessity of laying out each hole separately.

The last few weeks of the third year are devoted to lectures on factory organization and factory systems. A boy too often acquires the idea, which sticks to him even after he has become a journeyman, that a foreman is after all nothing but a slave driver, whose chief duty is to obtain from the man the last ounce of work. We endeavor to show to the boy that the foreman is only one link, though an important one, in the big chain, which cannot operate if even the smallest link gives out. As soon as the boy begins to realize this, he begins to understand that even his own little efforts have their importance and are needed in the carrying on of the whole work; he will become a supporter rather than an antagonist of the foreman.

I attach quite an importance to these few lectures and to the effect they should have upon the future working men. An ambitious working man may inquire the reason for doing a certain thing in a certain way. What is the usual answer that most foremen will give him? They will tell him in a more or less polite way that it is none of his business; that he should bother about his own work and not waste time by asking such questions. I believe most decidedly that it is an ambitious man's business to understand, in a general way, the conditions that surround him and the reasons for carrying on work in the way in which he is directed to perform it. A question asked in the right spirit deserves some answer in the same spirit. The man will be benefited by it and the company will be better off for that.

I think it of sufficient interest to state here a psychological element in our school work. If we ask a boy to figure out the weight of a piece of brass three inches long by one inch in diameter and tell him that he is wrong if his calculation does not give the proper figure, he may assume an attitude of antagonism to the teacher. We give to the boy a piece of brass, let him measure the same and sketch it on a piece of paper and calculate the weight. We then hand to the boy a pair of scales to check his own results. If now the scales tell him that he is wrong, he will feel rather ashamed of himself and re-calculate the problem with the earnest desire of arriving at the proper figure. The boy has, so to speak, a greater confidence in the veracity of the scales than in the veracity of the teacher.

An examination is held at the end of each term, and only those apprentices who obtain a percentage of 60 or more are allowed to advance to the next school term. Some have been left behind. The knowledge of their failure, however, became quickly known among their shop-mates and had a most stimulating effect on the mental machinery of these boys. The final examination after three years of schooling is a competitive one, wherein everyone who obtains a percentage of 95 or more is presented by the company with a technical book or a useful working tool. The standing obtained in the school is also stated in the "certificate of apprenticeship," which is given to the boy at the successful termination of his apprenticeship, together with a cash bonus of $100.

Practical Training.

At the same time with the theoretical instruction in the school, practical instruction in the handling of tools was carried on in the shop. We soon recognized, however, that there must be a very close connection between the theoretical and the practical instruction, so that a boy may be stimulated to apply every day to the work-shop what the school has taught him. The difficulty can easily be understood of giving systematic practical instruction in the factory with an equal chance of giving the same training to all boys and yet of taking into account the individuality of every apprentice—the quickness of his mental grasp, the dexterity of his hand.

The work which apprentices perform in the different shop departments must of necessity be governed to a large extent by production requirements. One department may be very busy to-day and may offer splendid opportunities for the boys, while to-morrow, it may have to work up only a small amount of production of a character, perhaps, which does not give the apprentices a really good chance. Then, again, the practical instruction in the shop is influenced materially by the individuality of the workmen, assistant foremen and foremen, all of whom act as instructors to the boys.

In order to equalize and improve the conditions it was decided a year and a half ago to concentrate the first practical instruction in a separate department, the apprentice training room, and to make the factory a post-graduate course, for the purpose of acquiring increased speed and accuracy on a greater variety of work. The factory would then not only apply the finishing touches to the boy's practical education, but would bring him face to face with real factory conditions and the emergencies that arise. The apprentice training room is, therefore, a second part of the apprentice school and may justly be called a trade school in contradistinction to the theoretical school which we have just described. The training room is in charge of a man who is not only an expert mechanician with inventive ability, but one who takes an interest in boys and understands how to handle them. This man, therefore, has the responsibility of not only initiating the boys into the trade in such a manner as to lay a solid foundation for their future work, but also of arousing in them the proper interest in and respect for manual labor. He furthermore has the opportunity of studying closely the boy's make-up, so that he may drop from the apprentice course those who do not display the qualities which are essential for a successful career, and he has a chance to develop an inventive capacity in those who by nature are endowed with inventive minds.

Every apprentice has first to enter the training room, where he will be kept from nine to twelve months, according to his ability. Bench-work during the first month is followed by work on simple machines, such as drill presses, from which the boy advances to work of a more difficult character on different lathes, on planers and shapers, on boring mills and milling machines. Some old machines have been rescued from the scrap heap and placed in the Trade School, in order to afford the boys a chance to make repairs—an excellent training for a machinist and an opportunity to develop the ability to meet emergencies. They are also taught to take care, for a short time, of the stock room, which is a part of the training room, and to perform such clerical work as making out time-cards and order blanks, which is required of every assistant fore-

man and foreman. During the last few months of their stay in the trade school, the best boys act as assistants to the man in charge, looking after some of the new apprentices.

The present equipment of our training room is limited, due to lack of sufficient room, so that we can take care in it of only about forty apprentices at a time, while about 150 apprentices are distributed through the shop. As those at the top are graduated into the factory post-graduate course, new freshmen, or, rather, fresh young men are taken in. We expect to move into a large, well-equipped building in the near future, when we shall be able to accommodate a larger number of apprentices.

The object of our whole apprenticeship system, as I have already pointed out, is to develop a very high class of employes. Their technical education should therefore be of as broad a character as possible, because with this better education goes a greater sense of responsibility, a firmer grasp of the work, a better understanding of the business methods. This aim cannot fully be accomplished within the compass of our theoretical school. I have therefore supplemented this school by an apprentice club, where the apprentices may congregate in their leisure hours for social as well as educational enjoyment. Expert engineers lecture to the boys once a week on various subjects which are allied to their business and stand ready to enlighten the boys further by answering any questions which may be asked during discussion. The club has been handsomely furnished by the company, but is conducted by the boys themselves, with a representative of the company on the board of directors. It is very interesting to observe how well the boys conduct the business of their club, which develops in them a business instinct and self-reliance.

These three institutions, therefore, namely, the theoretical school, the trade school, and the apprentice club, constitute the apprentice school of the Thomson-Houston (General Electric) Company at West Lynn, of which you did me the honor to invite me to speak to you to-night.

There have been certain changes in the apprenticeship school of the General Electric Co. since the address, of which the foregoing is an abstract, was delivered. Mr. Alexander writes that a new course of studies has been adopted and that the school is held from 3 to 6 P. M., instead of in the morning, with two sessions per week for each pupil. The standard of the whole apprenticeship system has been raised and on account of the greater discrimination made among those who are accepted for apprenticeship an increased wage schedule has been decided upon and carried into effect, as follows:

For the trial period.....	8	cents	per	hour
For the first six months.....	8	"	"	"
For the second six months.....	10	"	"	"
For the second year	12	"	"	"
For the third year	14	"	"	"
For the fourth year.....	16.5	"	"	"

with the same bonus of $100 cash.

It is interesting to note that an increasing number of high-school graduates are taking the apprenticeship course at the works.—EDITOR.

* * *

One of the interesting developments of automobile construction is the extensive use of ball bearings in the transmission machinery. While ball bearings are by no means a new thing, their limitations have generally been supposed to prevent their use where reciprocating action involving heavy stresses was necessary. The success of ball bearings applied to the crankshafts of automobile engines suggests the idea that it may be feasible to do away with the expensive crankshaft as now made and substitute a shaft having instead of cranks, cams or eccentrics equal in throw to the stroke of the piston. The connecting-rods would then be in appearance similar to eccentric straps, fitted with ball bearings. The use of eccentrics with plain bearings is, of course, out of the question because of the large proportion of the power wasted in friction, and the consequent heating, but with ball bearings the friction loss is comparatively small, and, provided ball bearings can be made to stand the peripheral speed necessary with eccentrics running at 600 or 800 revolutions per minute, it may be that this construction offers a way of escaping the manufacture of one of the most expensive parts of the four-cylinder engine, that is, the four-throw crankshaft.

REPRESENTATIVE AMERICAN MECHANICS.

CHRISTOPHER M. SPENCER

Christopher Miner Spencer was born at South Manchester, Conn., June 20, 1833. At the age of 12 he went to live with his grandfather, a Revolutionary soldier, and while living there he first evinced his taste for firearms and native mechanical ability by sawing off the end of his grandfather's musket so that he could use it for squirrel shooting. To do it he used an old table knife which he had converted into a hack-saw, notching teeth on the back by striking it on the edge of an old ax. In 1847, at the age of 14, he went to work for Cheney Bros., silk manufacturers at South Manchester. Leaving there, temporarily, he went with Samuel Loomis at Manchester to serve eight months apprenticeship at the machinists' trade. He went to school the following winter, and again served another eight months' apprenticeship the following year. He then returned to Cheney Bros., and under the direction of Frank Cheney, began experimental work as a journeyman. Here he took out his first patent for a spooler. Desiring to obtain a wider mechanical experience than was possible in his native town, he left in 1853 and went to Rochester, N. Y., where he worked for about a year repairing locomotives. Further experience, this time on firearms, was gotten in the Ames works at Chicopee, Mass. Upon returning to Hartford he secured employment in Colt's Armory, and there conceived the invention of the Spencer repeating rifle, the first of the type to use metallic case ammunition. The metallic cartridge was the invention of C. D. Leet, of Springfield, Mass., and had heretofore been used only in single-shot rifles and revolvers. The first Spencer seven-shot rifle having the magazine in the stock was brought out in 1860. Cheney Bros. took up its manufacture, and gave Mr. Spencer a bonus of $5,000 and a royalty of $1 a gun. These rifles were largely used during the Civil War, something like 200,000 being made and sold to the government. During the war Mr. Spencer presented one of his rifles to Abraham Lincoln at the White House, and then he and Lincoln shot a score on the grounds near where the Washington Monument now stands. The target consisted of a pine board having a bullseye at each end, Lincoln shooting at one bullsye and Spencer at the other. This target is preserved in the museum at Springfield, Ill., along with other Lincoln relics. Mr. Spencer tells some interesting anecdotes concerning "Honest Abe" and considers that he was one of the most wonderful men he ever met. As an illustration of the unconventional manner in which government business was conducted at that time, Mr. Spencer says that when they were examining the rifle, Lincoln sent his eldest son, Robert, over to the War Department to call on Secretary Stanton to see the gun, but Stanton sent back word that he was "too busy." Lincoln sighed, and said, "You see they do pretty near as they please around here"; but as a matter of fact, no one could be firmer than he when necessary.

The manufacture of the gun had been transferred to the Spencer Repeating Arms Co., in Boston, Mass., but at the close of the war the demand ceased, and the company sold out to the Winchester Arms Co., New Haven, Conn. From there Mr. Spencer went to Amherst, Mass., and in company with Henry F. Hills organized the Roper Repeating Arms Co., to manufacture the Roper shot-gun. This venture was unsuccessful, and Mr. Spencer bought it out and removed it to Hartford. But in its manufacture he had gained valuable experience in the making of drop-forging, and in 1869, in company with C. E. Billings, he formed the Billings & Spencer Co., to manufacture drop-forgings.

A few years later he made the invention which marks an epoch in the machine tool business, and that is the Spencer automatic screw machine. The first machine was set to work in 1874, being a Pratt & Whitney turret lathe, to which was fitted the cam drums for making its operations automatic. This machine was fitted up on the second floor of the shop of the Cushman Chuck Co., which stands on Cushman Street. The Hartford Machine Screw Co. was organized in 1876 and the machines were built by the Pratt & Whitney Co. This business Mr. Spencer sold out in 1882 to again enter the manufacture of firearms. A company was formed which began in 1883 the manufacture of the "trombone" Spencer repeating shot-gun, at Windsor, being capitalized at $400,000.

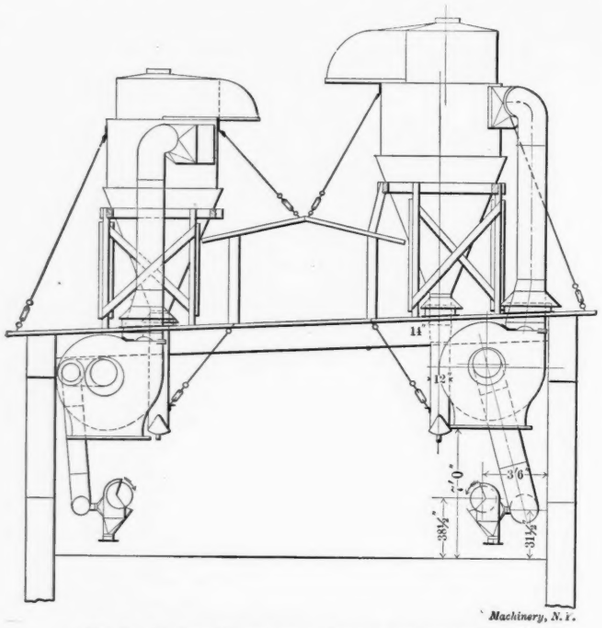


Fig. 2. Sectional Elevation of Dust Collecting System.

In 1883 Mr. Spencer, in company with a party, took the gun to Germany to introduce it, and while there met a number of famous German officers, who were well acquainted with the Spencer repeating rifle. Some of them asked him if he was a relative of the inventor of the repeating rifle, and when he informed them that he was the inventor, they were astonished beyond measure, and it was with difficulty that they were convinced. This venture was continued until 1888, when it was sold to Francis Bannerman, Brooklyn, N. Y., who continued the work there; Mr. Spencer withdrew, a poorer man for his experience.

Notwithstanding his brilliant genius and the inventions which he made, especially the automatic screw machine, he is to-day in very moderate circumstances. The thousands, or rather millions, of dollars which have been added to the world's productive capacity as a result of the automatic screw machine have gone to other people, as is generally the case with epoch-making inventions. Mr. Spencer is still active, and since 1888 has been devoting his time to the improvement of automobiles and automatic screw machines. He is now superintendent of the Universal Machine Screw Co., a concern recently organized in Hartford to manufacture an improved multiple-spindle machine of his design, having five working spindles.

EXHAUSTING ARRANGEMENT FOR GRINDING AND POLISHING WHEELS.

In the plant of the Victor Talking Machine Co., Camden, N. J., are installed, in a single room, twenty-two buffing wheels and eighteen grinding wheels. These are arranged in two groups, each equipped with a complete exhausting system connected to its individual fan and dust collector. The general construction of the hoods, arrangement of piping, and location of fan is indicated in Fig. 1, showing one side of the room. The hood in each case nearly encases the wheel but leaves ample space in front for the workman. Adjustable flaps at

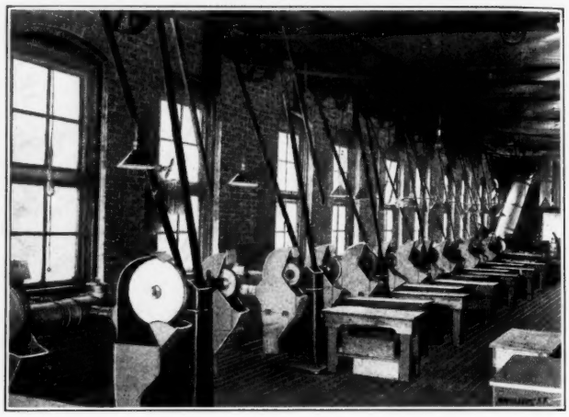


Fig. 1. Polishing Room of the Victor Talking Machine Co.

the top and bottom assist to prevent the throwing of dust and coarser particles into the room. The outer side of each hood is hinged so as to drop down out of the way and allow of the ready removal of the wheel. This arrangement is clearly shown in the case of the hood nearest the observer, as is also the method of connection of the exhaust pipe to the hood.

The design of the hood is such that all but the very finest material is thrown or falls to the hopper at the bottom, whence it may be periodically removed. The finer particles are drawn through the connecting pipe in the rear which expands as it approaches the hood so as to equalize the current of air and reduce the velocity of entry. As a natural result the fan draws away only the minute particles, thereby reducing the

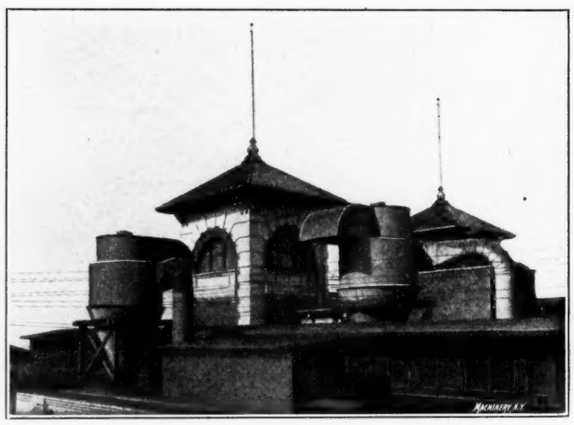


Fig. 3. Dust Collectors on the Roof.

chance of clogging and decreasing the work which the dust separators have to do. All hood connections enter horizontally a pipe which runs immediately behind the hoods and against the wall. Cleanouts placed at intervals along the top of this pipe make it possible to keep it perfectly clear.

From the fans the dust-laden air is discharged up through the roof into dust collectors, Fig. 2, each of which is provided with a special hood. The absence of dust in close proximity to the finely finished towers of the building is very clearly indicated by the photograph. The entire system was installed by C. H. Gifford & Co., managers of the Philadelphia house of the B. F. Sturtevant Co.

ARRANGING A BROWN & SHARPE CUTTER GRINDER FOR GRINDING SNAP GAGES.

A. C. LINDHOLM.

The cut, Fig. 1, illustrates a No. 3 B. & S. cutter grinder with a micrometer attachment placed at the right of the machine. This device consists of a casting *H*, which is clamped to the main guide-bar *M*. Another casting *F* is fastened with screws to the bearing *N* of the guide-bar. This part of the device has a tapped hole, 40 pitch, for the screw *L*; *K* is the graduated knurled head of the screw. The cut fully illustrates the device in position, also the plate *D*, which is fitted to the head *E*. This plate holds the work on gage *G* to be ground. *A* is the spindle and *B* the emery wheel of the grinder. Before adopting this device great care had to be taken to grind a gage correctly, the only arrangement being a clamp or stop on each end of the guide-bar having a knurled head screw with a coarse pitch.

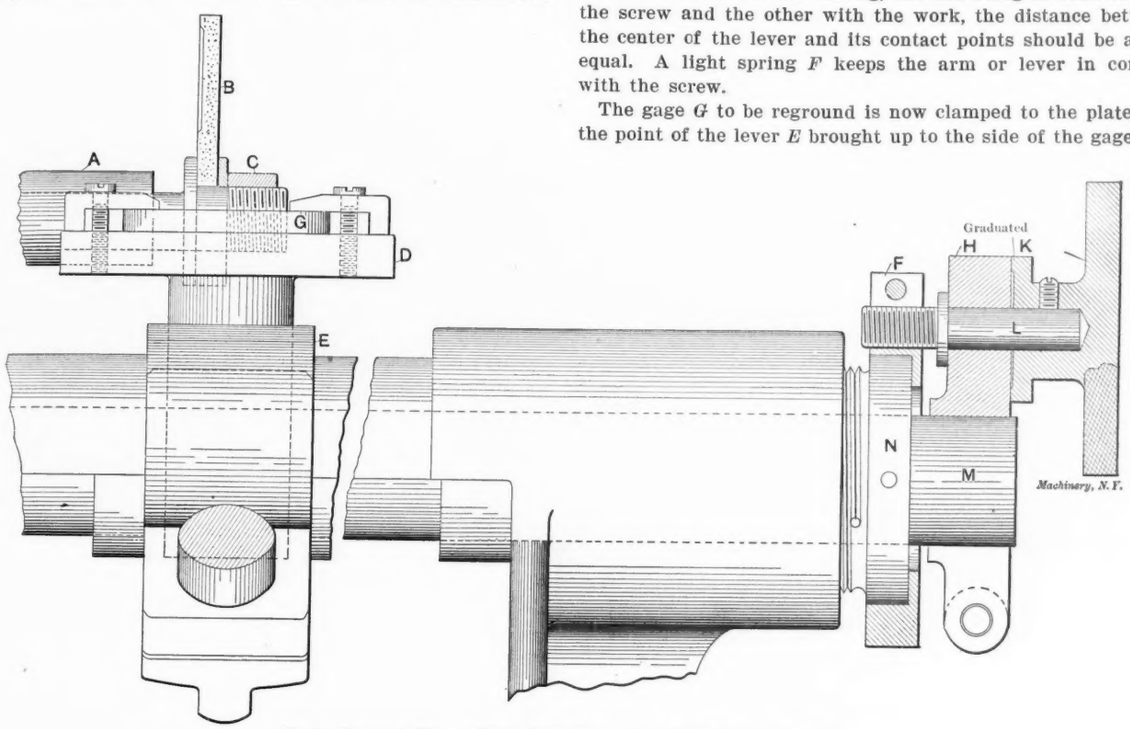


Fig. 1. Brown & Sharpe Cutter Grinder arranged to Grind Snap Gages.

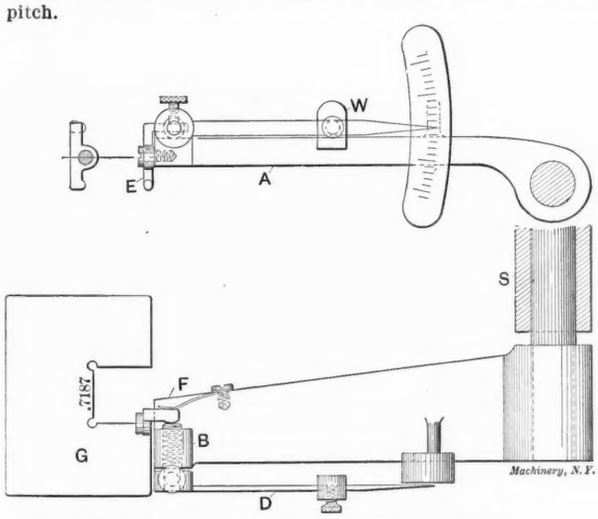


Fig. 2. A Micrometer Gage for Resetting the Work.

Often the dimensions of certain pieces of work are changed, allowing more limit to diameter or size as the case may be, increasing the limit one or two thousandths of an inch or more. This necessitates a new gage, or grinding the old one to the new size. When but a thousandth or two is to be taken out, great care must be taken in setting up the job correctly. The gage or indicator, Fig. 2, was designed for indicating a correct setting of the work. The casting *A* is of gray iron, into which is fitted an arbor which also fits the wheel spindle *S* of the grinder.

A 40-pitch thread is tapped in the projection *B* and a screw is fitted to same. At the end of the screw a pointer *D* is fastened for indicating the truth of the work. A small lever *E* is screwed fast to the casting, one end being in contact with the screw and the other with the work, the distance between the center of the lever and its contact points should be about equal. A light spring *F* keeps the arm or lever in contact with the screw.

The gage *G* to be reground is now clamped to the plate and the point of the lever *E* brought up to the side of the gage and the reading on the graduated arc is noted. The pointer is then raised and the head or gage is moved out to the end of the work so as to get the reading at both the inner and outer points. The pointer is lowered and the difference in the reading, if any, is noted. The weight *W* can be placed so as to give the desired tension. The graduation is in thousandths inch. The pointer must not be dropped suddenly but gradually, thereby giving a correct reading. During the setting the indicator is held rigidly in the wheel spindle, the latter being prevented from turning by setting up the take-up collar. In this manner the setting of the gage face parallel with the slide is assured.

* * *

Mr. C. W. Naylor, at the fall meeting of the A. S. M. E., related a peculiar experience with the bearings of a jack shaft in the engine room of a Chicago establishment. The shaft was of steel 5 inches in diameter and 18 feet long, running at 250 revolutions per minute, receiving and transmitting 175 indicated horse power from a pair of steam engines and driving by leather belts five electric generators. The pull of these belts, as well as that of the engine belt, was all in the same direction. The bearing boxes were 14 inches long, non-self-oiling and split horizontally, made of case iron and babbitt filled. For the first two years much trouble was experienced in keeping the boxes cooled with oil, of which several grades were tried, as well as various brands of grease. In 1890 Lake Michigan hydrant water was tried as a lubricant with such good results that it was continued until 1901, a period of eleven years, without any serious interruption, for ten hours each week day. A small stream of water was allowed to trickle through the bearings, and for five minutes before closing down oil was fed into the box to prevent the shaft from rusting and sticking over night when the machinery was not in use. The wear on the babbitt and box for the eleven years was about ¼ inch; on the shaft it was nil. The increase of temperature in shaft and box was inappreciable and less trouble was experienced with eleven years' use of water than with one month's use of oil. The plant was abandoned in 1901.

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MACHINERY

REGISTERED IN UNITED STATES PATENT OFFICE.

DESIGN—CONSTRUCTION—OPERATION.

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We solicit communications from practical men on subjects pertaining to machinery, for which the necessary illustrations will be made at our expense. All copy must reach us by the 5th of the month preceding publication.

APRIL, 1906.

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MACHINERY is published in four editions. The practical work of the shop is thoroughly covered in the Shop Edition—$1.00 a year, comprising more than 430 reading pages. The Engineering Edition—$2.00 a year—contains all the matter in the Shop Edition and about 250 pages a year of additional matter, which includes a review of mechanical literature, and forty-eight 6 x 9 data sheets filled with condensed data on machine design, engineering practice and shop work. The Foreign Edition, $3.00 a year, comprises the same matter as the Engineering. RAILWAY MACHINERY, $2.00 a year, is a special edition, including a variety of matter for railway shop work—same size as Engineering and same number of data sheets.

LOW-SPEED TOOLS AND HIGH-SPEED STEEL.

The following inquiries come to us from Germany in regard to high-speed steels: "I should like to hear the opinions of your readers as to the value of the new high-speed steels (1) when used on the old-fashioned machine tools not designed for the high cutting speeds possible with new tools; (2) for milling cutters and similar tools."

Definite information upon both of these subjects is badly needed, but the first part of the inquiry is after all the most important question that the shop superintendent has to deal with in introducing high-speed steels. Only those who can afford to throw out the old and put in the new are in a position to take full advantage of the increased output that is to be had from high-speed cutting tools. In the average shop this change of equipment must be in the nature of a gradual development extending over a period of several years. As one superintendent has expressed it, who presides over a shop that has not as good an equipment as he would like, "Traveling cranes, electrically-driven tools and high-speed steel have come upon us almost at the same time. What are we to do?"

There is some consolation, however, for those who have to get along with these conditions as best they can. The chief function of a machine tool is not in the majority of cases to remove the greatest possible weight of metal in a given length of time. In a manufacturing shop it is cheaper to have castings and forgings come somewhere near the finished size than to depend upon the lathe and planer to do it all and it is not economy to attempt to take a heavier cut than the stiffness and strength of the work itself will warrant, however heavy and modern the machine may be in which the work is placed. Furthermore, if the facts were known the foreman in any department of a shop would be surprised to find how small a percentage of the time was required for the actual cutting and how large a percentage for setting up and changing the work. We know of one case where a recording ammeter was attached to a planer and the line traced by the instrument showed the planer to have been on the waiting list 50 per cent of the time. Even in the Taylor system of rate setting, by which such remarkable results have been achieved, the gain does not all come from the high cutting speeds set for the work. A greater or less proportion of the saving, depending upon the character of the work itself, is due to the specific directions given for the order of operations and the precise manner in which they are to be performed.

The foregoing comments are made, not to advocate the use of old-fashioned machine tools in place of the modern, heavy tools, but to suggest that where it is not possible to get the new machines as rapidly as desired there are still opportunities for a substantial saving in time and money, not alone by speeding the old machines up as much as they will stand, but by giving attention to the other features that contribute towards the cost of machine shop work.

* * *

DENATURIZED ALCOHOL.

The prospects of a bill being passed by the present Congress for removing the tax from denaturized alcohol are not particularly encouraging, but educational work is going on which will eventually cause this desirable legislature to be enacted. Expert witnesses have been called before the House Committee on Ways and Means who have told of the great possibilities of cheap alcohol in the arts and industries and what it will mean to the agricultural interests of the country. In many parts of the country denaturized alcohol would be cheaper fuel than coal and as an illuminating fluid with the proper form of burner it would be cheaper and more satisfactory than kerosene. Naturally, therefore, every vested interest affected is working tooth and nail to defeat any such radical change as would be brought about by the abolishing of the tax, which is now $1.10 per "proof" gallon. The "proof" gallon is the basis for the tax and is a wine gallon (231 cubic inches) containing 50 per cent pure alcohol; if the alcohol is 90 per cent. pure, for example, the tax is $1.98 per gallon.

To show the beneficial effects of free alcohol on general industries, it is pointed out that the manufacture of artificial silk in Europe is made possible by its use, but in this country it is out of the question, for cotton cloth, treated with taxed alcohol in the manner prescribed for its manufacture, costs nearly or fully as much as the real silk article. The growing demand for gasoline for use in the internal combustion engines used on automobiles, motor boats and for general power purposes is steadily increasing the price of this article, which at best is of a very limited output, and there is little prospect of the supply of gasoline being materially increased. Most of the new oil territory that is being developed produces petroleum in which the lighter oils like benzine and gasoline are present in very small degree. Alcohol free from tax would mean that vast quantities of farm products which are now largely waste material, could be made into a product of universal use, for alcohol can be made from anything containing starch or sugar. Potatoes, turnips, corn stalks, beets, wood, sawdust, straw, or anything of this nature can be made to produce a certain measure of alcohol in apparatus of very simple and easily operated nature. It is claimed that from the corn stalks grown in the West many millions of gallons of alcohol could be made, it being estimated that from this source alone the value of the annual corn crop could be increased fully $25,000,000.

* * *

The adoption of an appropriate name for any manufacturing business is very important, for it oftentimes has a deciding effect in the success of the concern. If possible the name should tell the business and also the place. It is obvious that the name "Smith Bell Co." tells more than "Smith Manufacturing Co.," but "Schenectady Bell Co.," for example, is still better. It not only discloses the business but also the location of the concern so far as the name of the town is concerned, and this is usually enough. Such a name in the directory is self-explanatory but what is more important is that possible customers will more readily remember a concern so named. Advertisements in trade journals do not yield all their results immediately; it is no uncommon thing for firms to get answers to "ads" that appeared ten or twenty years before. Many more returns would be received if people could always remember "who" and "where." On the other hand, a firm name may tell too much. To illustrate, suppose for example the name of the concern is "Perkins Plow and Watch Co." It is conceivable, of course, that a concern could build both good plows and watches, but the combination is certainly in poor taste, both from a manufacturing standpoint and in the trade name. If a concern is engaged in dissimilar enterprises like this a blanket name that tells nothing would seem better than one that tells all.

ENGINEERING REVIEW.

CURRENT EVENTS, TECHNICAL AND MECHANICAL—LEADING ARTICLES OF THE MONTH.

Regarding the value of the exponent n in the expression $PV^n = \text{constant}$ Mr. C. P. Poole of *Power* in a letter to the *Horseless Age* of January 24 says its value may safely be taken as 1.3 for the compression curve and 1.35 for the expansion curve of a gas engine indicator diagram. This would indicate that the usual value of 1.41 given in the older text books is quite wide of the mark.

A correspondent of the *Engineer* describes a heating coil connection to an exhaust steam line, which introduces no back pressure. The radiator or heating coil supply is connected into the upper side of the exhaust pipe and the return or drip connection to the lower side of the exhaust, so that condensation will accumulate and form a water seal. This seal permits the condensation to overflow into the exhaust line gradually as it accumulates. It is plain that the combination acts as a vacuum system, the reduction in pressure being measured by the effective head of water in the discharge pipe. There should be an air cock on the heating coils at the drop connection for removal of air.

Some of the most interesting experiments in chemistry are made with simple apparatus and much of the work of the experimental laboratory is done with tools and appliances of a primitive nature. The *Mining Reporter* tells how small quantities of gold may be freed of mercury, which may be cited as a case in point. "To procure the gold from small quantities of amalgam, a potato retort may be made. Cut a medium sized potato in half and hollow out one piece. Now make a depression in an old shovel or piece of sheet iron and place the amalgam therein. Cover with the potato, taking care to make it fit snugly. Heat very slowly until the potato bakes fast to the iron and thus seals the retort. Then raise the heat and maintain it at redness for a few minutes. Upon subsequently removing the potato, the gold will be found free from mercury, and it can be further purified by boiling in nitric acid."

In an article on workmanship in riveting by Mr. A. J. Himes in the *Engineering News* a number of tests are given by which a loose rivet in a structural fabric may be detected. If loose the impact of a hammer on the head will produce a dull click or the looseness may be detected by sight, as a very slight motion will be observed. If the rivet head is in such a position that water can stand around it the very slightest vibration will be detected in the motion of the water. A tight rivet will cause the hammer to rebound freely, but if loose there is little recovery after impact. Again a finger laid against a rivet while struck with a hammer blow on the opposite end will detect any slight vibration due to looseness. The best way to detect looseness is to take a thin metal washer between the thumb and fore finger and hold it against the rivet head while the blow is struck by a small hammer on the opposite end. The slightest looseness can be readily detected in this manner.

The relative torsional strength of steel and wrought-iron pipes was tested by the National Tube Co. and reported in a paper read before the American Society of Heating and Ventilating Engineers. The pipes, in lengths of 6 feet each, were tested in an engine lathe. One end of the pipe to be tested was caught in a four-jaw chuck and the other end was supported on the tailstock center and also by the steadyrest. A lever was clamped to the tailstock end of the pipe, the outer end of which was supported by a spring balance at a radius of 3 feet. Tested in this manner a ½-inch steel pipe gave a maximum pull of 190 pounds and twisted fifteen turns before breaking, the weld remaining intact. The results with ½-inch iron pipe were much lower. With one lot the average pull at the end of the 3-foot lever was only 65 pounds and all the samples failed in the weld with 2½ turns. The best result was an average of 81 pounds pull, 5¾ turns, and the failure of 66 per cent in the weld. The next size, ¾-inch steel pipe, gave a maximum average pull of 172 pounds, and 8 turns before failure, of which only 13 per cent failed in the weld. Iron pipe of the same dimension gave in the best average test 154 pounds pull, 6.2 turns and .33 per cent failure in the weld. With 1-inch steel pipe, the average pull was 300 pounds, 5½ turns and 13 per cent failure in the weld. Iron pipe of the same size gave an average pull, in the best test, of 256 pounds, 4½ turns and 46 per cent failure in the weld; the poorest showing, as regards the integrity of the weld, was 258 pounds pull, 2¾ turns and 66 per cent failure in the weld.

In the December issue of MACHINERY (Engineering edition) mention was made of a device for testing the flow of artesian wells by means of a red aniline fluid injected into a horizontal section of pipe having a known diameter and length. The time required for the red fluid to show at the end of pipe gives the data necessary for calculating the flow of the well. A correspondent of the *Valve World* describes a variation of this method which has been used by well drillers and which does not require any additional pipe above ground. The plan is to lower a bottle of aniline fluid containing a dynamite cap connected by wire to a battery at the surface. When the bottle has been lowered to a depth of, say, 500 feet the cap is exploded and the bottle bursts. The lapse of time between the firing of the cap and the appearance of the colored water at the surface gives the data necessary for calculating the flow. It is claimed that the flow may be obtained in this manner as accurately as if measured by a weir.

The success of Niagara power development and the great returns realized on the original investment have naturally called attention to undeveloped water powers throughout the country. The possibility of electrically transmitting power 100 or 150 miles or more has made many water powers valuable which a few years ago were so remotely situated as to be of little or no value except for small local enterprises. In an article by Mr. Alton D. Adams in the *Electrical Review*, the possible power development of the Adirondack region is reviewed. It is stated that Adirondack water develops 200,000 continuous horse power in its descent to the sea level. On the basis of 300 ten-hour working days per year it means that this water would develop more than 500,000 horse power, provided of course that suitable storage reservoirs were made to hold the water during idle periods. In conclusion the author says, "Silence every steam engine in the State of New York, and Adirondack water will carry their loads, if storage is provided to conserve it; and electricity distributes its power."

The reduction of buildings to marketable materials instead of junk has reached the dignity of an important engineering profession in modern housewrecking. The tearing down of a collection of large buildings like those at the Pan-American or the Louisiana Purchase exposition so as to get marketable products with the minimum of waste requires much care and good judgment. In an article upon the subject in the January issues of *Cassier's Magazine*, Mr. Geo. E. Walsh reviews the growth of this industry. The steel skeletons of modern buildings are most valuable. They are taken down very carefully and the average housewrecker can dismember such a building so that the loss is restricted almost entirely to the rivets. This old material is used in new structures, the structures often being designed so as to fit the available material. Where it is known that structures such as those for expositions are to be demolished after their close it is part of the business of the wrecking companies to keep careful account of all the material entering the structure so as to be able to estimate intelligently upon its value after its demolition.

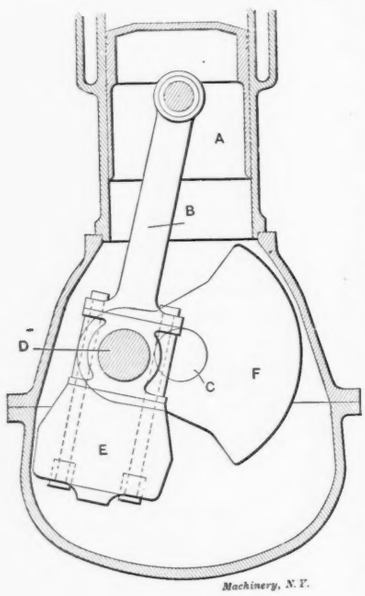
Hydrofluoric acid as a cleaning agent for castings has not been in general use for any great length of time, and a few years ago was treated as a secret process by those who understood its value and made use of it in removing sand from castings, says a writer in the *Foundry*. Several formulas have been

sold for this pickle for considerable sums, said formula having several superfluous ingredients in them to mystify the unsuspecting buyer. But the fact is, anything used in connection with this pickle besides hydrofluoric acid and water is entirely unnecessary. The usual formula for removing sand from brass castings is hydrofluoric acid 1 part and water 10 parts. It must be remembered, however, that this acid comes in different degrees of purity; if the weaker acid is used, less water is added to the drip; if the stronger grades are used, more water should be added, but there is no set rule as to the amount of acid to be used. The idea is to get a dip that will remove the sand quickly and perfectly from the casting; this operation usually requires from 10 to 15 minutes depending entirely upon the amount of sand to be removed and the condition of the pickle; of course, a newly-made pickle works much faster and cleaner than one that has been in use for some time.

METHOD OF BALANCING GAS ENGINES.

Mechanical Engineer, February 24, 1906.

A patent has recently been granted to Armstrong, Whitworth & Co., Ltd., and W. G. Wilson, of Elswick Works, Newcastle-on-Tyne, for a method of balancing steam and other engines, more particularly explosion engines. For the purpose of balancing the moving parts a weight is attached to the connecting rod on the other side of the crank pin to the cylinder. This weight and its distance from the crank pin is such that the center of gravity of the piston, the connecting rod, and weight is at the crank pin. In the case of single-cylinder engines, a weight is also attached to the crank, on the opposite side of the crank shaft to the crank pin. This weight, and its distance from the crank shaft, is such that the center of gravity of it, the other weight, the connecting-rod, and the piston is at the crank shaft. In engines having two or more cylinders, the dimensions of the second weight may be varied according to the degree to which the several cranks balance each other.



The accompanying illustration shows a section of an engine fitted with the balancing arrangement. *A* is the piston, *B* the connecting rod, *C* the crank shaft, and *D* the crank pin. *E* is a weight attached to the connecting rod, such that the center of gravity of the piston *A*, the connecting rod *B*, and the weight *E* is as near as may be at the center of the crank pin. *F* is a weight attached to the crank, such that the center of gravity of the piston *A*, the connecting rod *B*, and weights *E* and *F* is as near as may be at the center of the crank shaft.

AN ICE AUTOMOBILE.

Scientific American, February 24, 1906, p. 174.

The development of the steamship, the locomotive and the automobile, and the still later conception of the dirigible airship, would seem to have exhausted the field of novel means of transportation. Yet a machine which is in its basic principle a decided innovation, has been designed and constructed by a Minneapolis man, Charles E. S. Burch, who has experimented for years in practical demonsfration of his idea. The machine in question is now resting on the ice of Lake Calhoun, where it has been tested, for, it must be understood, the machine is intended to travel on a frozen surface. The object which the inventor has had in view is the revolutionizing of the means of winter transportation in Alaska, where he is heavily interested in mining properties difficult to develop because of their inaccessibility. At present, in certain parts of Alaska, freight transpprtation during the winter is accomplished entirely by dog-teams and sleds, and in consequence the charges are from $100 to $1,000 a ton. It is the inventor's plan to use in place of dog-teams his "ice locomotive" drawing a train of sleds, and in this way to reduce the expense of freighting to a minimum. It is hoped that the invention will prove a boon to winter commerce in Alaska, and should it succeed will doubtless be received with enthusiasm by the thousands in that frozen country, who in winter are practically shut out from the civilized world.

The ice locomotive is propelled by steam engines, but instead of resting on wheels or runners is supported by four great steel spirals, one at each corner of the body, in the places usually occupied by the wheels or runners of ordinary vehicles. The spirals lie with their axes horizontal, and are of right- and left-hand pitch for the opposite sides. The edges of the blades are fashioned like skate blades in order that they may grip the ice well. Each of the spirals is directly connected to a separate steam engine and consequently the spirals may be operated independently, this method giving unusual control over the car. It can be driven forward, backward, sideways or at any oblique angle desired, and it can even be made to spin around like a top. The model now at Lake Calhoun is 22 feet long, weighs 4½ tons, has engines of 42 horse-power and steel screws 27 inches in diameter. It is easily seen that the greater the diameter of the spirals the greater will be the ability of the ice locomotive to travel over rough surfaces and to surmount obstacles. Accordingly, a machine which the inventor is having built in Canada, to protect patent rights in that country, will have spirals six feet in height. The ice locomotive is steered by means of two semi-circular steel disks at each end of the body operated by compressed air. The disks work in unison and are weighted in order better to grip the ice. The bottom of the body is made watertight so that in the event of the machine breaking through the ice it will float upon the surface of the water. In that case the spirals would act as propellers.

The Lake Calhoun machine, which is unfinished and rough in appearance, was constructed to make an estimated speed of 9 miles an hour; but on its trial trip it easily traveled at the rate of 18 miles an hour. Obstacles and rough places were passed with surprising ease. A toboggan slide course of ice and snow several feet above tne level of the lake ice was surmounted without difficulty while traveling at full speed.

SUGGESTED IMPROVEMENTS IN THE AUTOMOBILE.

An automobile which answers the requirements of doctors' use in the country must be a very reliable machine. That the present types of automobiles do not in all respects answer these requirements is pretty well known, notwithstanding the fact that many doctors are using them with satisfaction where the roads are in good repair. A paper was read by Dr. Hard before the Southern Minnesota Medical Society and published in the *Horseless Age* in which the author points out some of the features of the modern automobile which, in his opinion, could be changed with profit. One of these is the differential in the rear axle by means of which the driving wheels adapt themselves to the difference in distances traveled by the rear wheels in turning curves. This mechanism is intricate, weakens the rear axle, is cumbersome and expensive. It has many objectionable features and is the cause of much trouble. It reduces the clearance over the middle of the road to eight inches in most of the automobiles now in use. This is not sufficient to clear many of the stones and other obstructions found so frequently in the middle of country roads. To strike one of these means disaster to the machine, with great delay and expense. When a differential gear is used the axle is made in two pieces, greatly reducing the strength, while it increases the weight and structural difficulties. The tendency to skid on slippery roads is largely due to the action on the drive wheels produced by the differential, the differential making the traction of one wheel depend upon the adhesion

of the other drive wheel to the ground. In other words, if one drive wheel requires twenty pounds of force to make it slip in the mud, the other drive wheel cannot exert that amount of force on the dry ground to help the machine out of the mud-hole. The excess of power is wasted in making the slipping wheel spin around, because of the fact that each drive wheel depends upon the opposition of its fellow for its tractive power. The doctor's ideas for obviating the differential are as follows: Have the drive wheels run free on a solid axle and get their power by independent chains from small sprockets engaged by cone clutches on the ends of the main shaft. In turning a corner or curve, deflection of the front wheels from straightaway to the extent of 12 degrees by the steering machanism results in automatically releasing one of the clutches, so that one drive wheel runs free while the other propels the carriage around the corner. As the front wheels straighten, the clutch again engages, and both drive wheels act equally to propel the carriage. This is a very simple arrangement, and provides for all the advantages of the differential without its presence nor any of its troubles.

WHAT IS AN ALLOY?

Prof. A. Humboldt Sexton, in the Mechanical Engineer, January 27, 1906.

When two or more metals are melted together they, as a rule, remain intimately mixed, showing little tendency to separate according to their density, or as it may be otherwise expressed, they remain in solution one in the other while they are in the liquid condition. When the mass solidifies this state of uniform distribution or mixture may continue, or it may be broken up. In the former case the solidified mass will contain the constituent metals in a condition of more or less uniform diffusion, and such a mass is called an alloy. In the latter case the metals will separate according to their specific gravity, the heavier metal going to the bottom and the lighter rising to the top, such separation being as a rule the more complete the slower the solidification. The separated metals in this case are rarely if ever pure, but each retains a small quantity of the other, and strictly speaking both are therefore alloys. In practice, however, the term alloy is restricted to those cases in which neither of the metals is present in very small proportion; the other cases being simply considered as metals containing an impurity.

An alloy is, then, an intimate mixture of two or more metals, and the term mixed metals has sometimes been used in place of alloys. This is, however, very misleading, as the alloys are much more than mere mixtures, and mixtures of metals may exist which are not alloys.

If lead and copper be melted together, and the mixture be slowly cooled, the metals will separate. If, however, the mixture be quickly cooled separation cannot take place and the metals will remain mechanically mixed the one with the other, they not having had time to separate into distinct layers, but the mass will consist of intermixed particles of the two metals, and if it be heated up to the melting point of lead this metal may be, to a large extent, melted out. This would be a case of a mixture of metals, but not of an alloy. In an alloy the mixture must be of such a character that the constituent metals lose their individuality, and become blended into a new substance which has properties, to some extent at least, unlike that of its constituents.

As a rule, substances which are not elements are divided into the two classes, chemical compounds and mechanical mixtures, but the metallic alloy cannot be made to fit exactly into either group. In a mere mixture the particles, however small and however intimately they may be mixed, always retain their individuality, and the properties of the mixture are always a mean of that of its constituents. If the constituents be black and white the mixture will be grey, if red and white, a paler shade of red, and so on through all the other properties. This, as is well known, is not the case with alloys. Brass containing, say, 50 per cent of copper and 50 per cent of zinc, is yellow, and this yellow color is certainly not a mean between the red of the copper and the bluish white of the zinc; nor is it specific gravity, or indeed any other property, a mean between those of its constituents. The only point in which alloys always resemble their constituents is in the fact that they are distinctly metallic.

Alloys, then, are not mechanical mixtures.

A chemical compound contains the elements in fixed proportions, these being always simple multiples of the atomic weights, and some of the physical properties follow from the molecular weight of the compound. This is not the case with alloys. As a rule, the metals are not present in any simple atomic proportion, and further the proportions can be varied within, often, wide limits without producing any serious change in the properties of the alloy.

The metals do not show any strong chemical affinity one for another, but there is no doubt that in some cases definite chemical compounds of the metals do exist, but in no case do they form alloys of any industrial importance.

Solutions.—There is still another form in which substances can exist which, while not a mere mechanical mixture, is something less than chemical combination. If salt or any other soluble substance be stirred up with water it disappears, or dissolves in the water, and the result is a solution of the salt. This solution has some of the properties of the salt; it has, for instance, a salt taste, yet its properties cannot be said to be a mean between those of water and salt. The salt dissolves without increasing the volume of the solution, so that the solution is denser than the mean between salt and water. The addition of the salt also lowers the freezing point of the water, so that the freezing point of the solution, instead of being a mean between that of water and salt, is lower than that of either, and by the addition of proper proportions of salt may be reduced to about — 22.5 degrees C.

The essential character of a solution is that the constituents are so intimately mixed, probably the mixture being actually molecular, that they cannot be separated or detected by mechanical means, while at the same time they have not entered into true chemical combination.

As a rule, when a solution is solidified, the constituents separate one from another to a larger or smaller extent, but this is not always the case. We can imagine a solution to become solid, and the result would then be a solid solution in which the bodies would still be so intimately mixed that no mechanical separation would be possible, and in which the properties would not be a mean of those of its constituents, but in which these constituents would not be present in the definite proportions required for a chemical compound.

True alloys are never mere mechanical mixtures of metals. Though in some cases the metals do combine, yielding definite chemical compounds, none of these compounds are of any use in the arts. Alloys are very frequently solid solutions of one metal in another, or of a chemical compound of the metals in the metal which is in excess. Many consist of mixtures of such solutions with definite substances that have crystallized out during cooling, so that the actual composition and structure may vary very widely; and each alloy, or rather group of alloys, must be studied separately, as it is impossible to lay down any except the most general rules.

WHY BRASS VALVES LEAK.

The manufacturers of the best brass valves, we believe, test each valve under hydraulic pressure before it is sent out from the factory, yet they frequently leak when erected in the pipe lines. A recent issue of the *Valve World* tells some of the reasons for this fault and shows that it is due to the misuse of the erector in most cases. The points are well worth remembering and may be profitably used in the instruction of apprentices and the older men too, perhaps. The following are the principal bad practises to be avoided:

1. Screwing a valve on a pipe very tightly, without first closing the valve. Closing the valve makes the body much more rigid and able to withstand greater strains and also keeps the iron chips, pipe cement, etc., from lodging under the seats, or in the working parts of valves. This, of course, does not apply to check valves.

2. Screwing a long mill thread into a valve. The threads on commercial pipes are very long and should never be screwed into a valve. An elbow or tee will stand the length of thread very well, but a suitable length thread should be cut in every

case on the pipe, when used to screw into a valve. If not, the end of pipe will shoulder against the seat of valve and so distort it that the valve will leak very badly.

3. The application of a pipe wrench on the opposite end of valve from the end which is being screwed on pipe. This should never be done as it invariably springs or forces the valve seats from their true original bearing with the disks.

4. Never place the body of a valve in the vise to remove the bonnet or center piece from a valve as it will squeeze together the soft brass body and throw all parts out of alignment. To properly remove the bonnet or center piece from a valve, either screw into each end of the valve a short piece of pipe and place one piece of the pipe in the vise, using a wrench on the square of bonnet; or if the vise is properly constructed, place the square of the bonnet in same and use the short piece of pipe screwed in each end as a lever. When using a wrench on square of bonnet or center piece, we recommend the use of a Stillson or Trimo wrench with a piece of tin between the teeth of the jaws and the finished brass. It may mark the brass slightly, but this is preferable to rounding off all the corners with an old monkey wrench which is worn out and sprung. As the threads on all bonnets or center pieces are doped with litharge or cement, a sharp jerk or jar on the wrench will start the bonnet much more quickly than a steady pull. Under no circumstances try to replace or remove the bonnet or center piece of a valve without first opening the same wide. This will prevent bending the stem, forcing the disk down through the seat or stripping the threads on bonnet where it screws into body. If found impossible to remove bonnet or center piece by ordinary methods, heat the body of valve just outside the thread. Then tap lightly all around the thread with a soft hammer. This method never fails, as the heat expands the body ring and breaks the joint made by the litharge or cement.

5. The application of a large monkey wrench to the stuffing box of valve. Many valves are returned with the stuffing boxes split or the threads in same stripped. This is caused by the fitter or engineer using a large sized monkey wrench on this small part.

6. The screwing into a valve of a long length of unsupported pipe. Say, for example, that the fitter is doing some repair work and starts out with a run of 2-inch horizontal pipe from a 2-inch valve connected to main steam header. The pipe is about 18 feet long, and after he has screwed the pipe tightly into valve, he leaves the helper to support the pipe at the other end, while he gets the hanger ready. The helper in the meantime has become tired and drops his shoulder on which the pipe rests about 3 inches and in consequence the full weight of this 18-foot length of pipe bears on the valve. The valve is badly sprung and when the engineer raises steam the next morning the valve leaks. When a valve is placed in the center of a long run of pipe, the pipe on each side, and close to the valve, should be well supported.

7. The use of pipe-cement in valves. When it is necessary to use pipe cement in joints, this mixture should always be placed on the pipe thread which screws into valve, and never in the valve itself. If the cement is placed in the valve, as the pipe is screwed into valve it forces the cement between the seats and discs, where it will soon harden and thus prevent the valve from seating properly.

8. Thread chips and scale in pipe. Before a pipe is screwed into a valve, it should be stood in a vertical position and struck sharply with a hammer. This will release the chips from thread cutting, also loosen the scale inside of pipe. When a pipe line containing valves is connected up, the valves should all be opened wide and the pipe well blown out before they are again closed. This will remove foreign substances which are liable to cut and scratch the seats and disks.

9. Expansion and contraction. Ample allowance must be provided for expansion and contraction in all steam lines, especially when brass valves are included. The pipe and fittings are much more rigid and stiff than the brass valves and in consequence the expansion strains will relieve themselves at the weakest point, unless otherwise provided for.

10. The use of wrenches or bars on valve wheels to close same tightly. This should never be done as it springs the entire valve and throws all parts out of alignment, thus making the valve leak. The manufacturer furnishes a wheel sufficiently large to properly close against any pressure for which same is suitable. If the valves cannot be closed tightly by this means, there is something between the disks and seats or they have been cut or scratched by foreign substances.

THE FUTURE OF THE AUTOMOBILE.

Abstract of article by Mr Winthrop E. Scarritt, in Cassier's Magazine, March, 1906.

The American car to-day closely follows the general lines of the French automobile. It is a well-known fact that the so-called gasoline car, or internal combustion motor, has almost displaced the steam type. There is only one steam car on the American market that has demonstrated its practicability. In gasoline automobiles, multiple cylinders are the rule. There are makers who are beginning to manufacture even six-cylinder cars, and these are found to be quite successful. The shaft-driven car is also largely taking the place of the chain drive. Formerly, it was thought that the shaft drive could not be used for the large car, but the success of the shaft-driven cars more recently has demonstrated the fallacy of this idea.

The principal criticism which has been made of American cars heretofore—which statement is not confined to American cars alone—is that they are unreliable. The idiosyncrasies of the gas engine are well known. It sometimes takes an expert an hour to discover a slight trouble, which when found may be remedied in five minutes. Through better material, better workmanship, and close attention to details and adjustment, the motor cars have become far more reliable than they were two years ago. It is now an exception to see an automobile laid up on the highway for anything except tire troubles, and even these are far less frequent than they were formerly. This comes about through two facts—the tire makers are putting better material into their products, and the manufacturers of automobiles are insisting on the use of a larger tire for a given weight than heretofore.

Edison has pointed out a strange paradox in the automobile. He says that the only thing which makes the automobile possible and practicable is the pneumatic tire, and at the same time the pneumatic tire is the weakest point in the automobile. The solid rubber tire, while successfully used on commercial vehicles at slow speeds, has not been, and cannot be, successfully used on touring cars or racing machines. The writer has made some experiments along this line, and has found that the jar and hammer incident to driving a touring car over rough roads are so great that the machinery of the motor car will not stand the shocks and strains.

The fuel problem is becoming a serious one for the automobilist. Within the past ten years, the demand for gasoline has increased enormously, and the price has almost doubled, while the supply has increased but little. The oil fields of Texas and California do not furnish the kind of oil from which gasoline can be manufactured. It is a fact not well known that the farmers of America use more gasoline than the automobilist. Eight hundred thousand gasoline stoves are in use throughout the western portion of the United States where fuel is high in price. The supply of gasoline within five years or less will be entirely inadequate to the demand, and the price will necessarily advance to prohibitive figures.

The most practical solution of the matter is to secure the passage of an act by Congress taking off the tax on denaturized alcohol used for commercial purposes. This is now being agitated. The present tax is $2.08 per gallon [95 per cent alcohol or the equivalent of 1.9 "proof" gallons]. Vegetable alcohol may be made from corn, beets, potatoes—in fact, from any of the starchy products. It can be made and sold at a price which is no greater than that now paid for gasoline. Last year over two hundred million gallons of vegetable alcohol were used in Germany.

The standard car of the future, whether for pleasure or business, will be of the gasoline type. It will be simple, and will be constructed of the highest grade of material known to the art. Reliability rather than speed will be the great desideratum. It will become standardized, and when standardized it can be made in large quantities at a low cost. I believe the automobile, so far as cost is concerned, will follow

the way of the bicycle. In the near future I expect to see a very fair runabout sold for $300, and the same grade of touring car for $500.

In conclusion, it may be well to consider some problems which are to be solved by this new factor in civilization. First, it will tend to prevent traffic congestion in city streets. A single example: What would it be worth if Broadway, New York's main thoroughfare, could be doubled in width from its lower end for a distance of, say, nine miles? Broadway is no wider than it was a hundred years ago, and yet the traffic upon this highway is a hundredfold greater than it was then. A horse driven truck starting from one end will make the nine-mile trip in two hours, carrying a load of a ton and a half. Substitute the motor truck and what follows? The space occupied by the horse, which is about equal to that of the truck, is saved. Further, the motor car will carry three tons, and can make the trip in just half the time of the horse-drawn vehicle. Thus, it is seen that the use of the motor vehicle would not only double, but more than treble, in effect, the width of the street.

Second, the automobile will tend to solve the tenement house problem. Automobiles ultimately will be built and sold at so low a cost that the average city workman will be able to own one, as he now owns his bicycle. Thus, he will be enabled to own his acre, away in the country, and bring up his children in the sunshine and fresh air among far more pleasant and healthful surroundings than are possible in the crowded tenement house districts of large cities.

Third, the use of the automobile in country districts will tend to keep the young people from flocking to the cities. The automobile will make life on the farm more pleasant. Young people will be able to go about visiting neighbors and friends even in adjoining counties, and in the future we shall probably hear less of "abandoned farms."

Fourth, the automobile will become indispensable to the physician, and I have no doubt that countless human lives will be saved, because, through the use of the motor car, the physician will be enabled to reach patients in a critical condition more quickly than by any other available means. The automobile will also become invaluable to firemen, to officers of the law, and to others in situations where great speed of transit is a desideratum.

TESTS OF HIGH-SPEED TOOL STEELS ON CAST IRON.

Abstract from Pamphlet issued by the Illinois Engineering Experiment Station, at the University of Illinois.

In the report, from which the following abstract is taken, are described experiments conducted under the direction of Prof. L. P. Breckenridge of the University of Illinois. The experiments were made by Mr. H. B. Dirks, Assistant in Mechanical Technology, Engineering Experiment Station, in the shops of the College of Engineering at the University of Illinois. These experiments have been in progress for nearly a year.

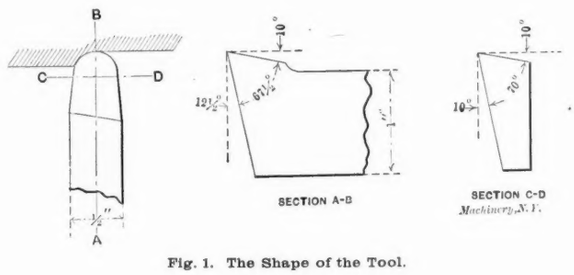


Fig. 1. The Shape of the Tool.

I. The Tool Steel Used.

The Brands Used.—The following tool steels were used in these trials:

1. Styrian marked "Böhler Rapid."
2. Jessop's "Ark."
3. McInness's "Extra."
4. Mushet's "Special."
5. "Air Novo."

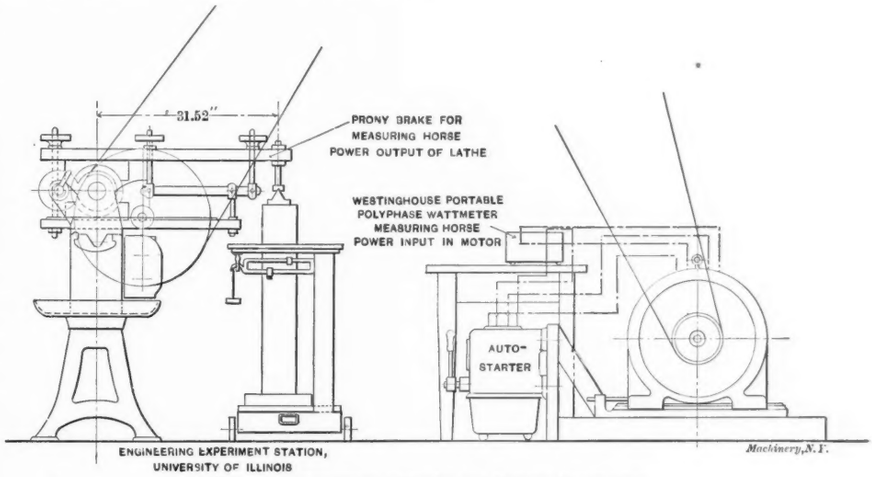

31.52"
PRONY BRAKE FOR MEASURING HORSE POWER OUTPUT OF LATHE
WESTINGHOUSE PORTABLE POLYPHASE WATTMETER MEASURING HORSE POWER INPUT IN MOTOR
AUTO-STARTER
ENGINEERING EXPERIMENT STATION, UNIVERSITY OF ILLINOIS
Machinery, N.Y.

Fig. 2. Arrangement of Brake and Driving Mechanism.

6. "Rex."
7. "Poldi."
8. "A. and W" (Armstrong and Whitworth).

Size and Shape of Tools.—The size of the bars of steel from which the tools were made was ½ inch by 1 inch for the steels from the American market. The Poldi bar was ¾ inch by 1¾ inch, and the "A. and W" bar was ¾ inch by 1¼ inch. The shape of the tool used in the tests is shown in Fig. 1. The front clearance was 12½ deg., the top rake was 10 deg., and the side rake was also 10 deg. Experiments relating to the proper shape of tools have been made by Professor J. T. Nicolson, and the writers were guided in selecting proper tool angles by the recommendations of his paper. Professor Nicolson says: "Tools should therefore be ground for maximum endurance in the cutting of cast iron in ordinary shop practice so that their true cutting angles are about 81 deg., or if they are allowed 6 deg. clearance for working on the level of the lathe centers, they should have an included angle of about 75 deg.

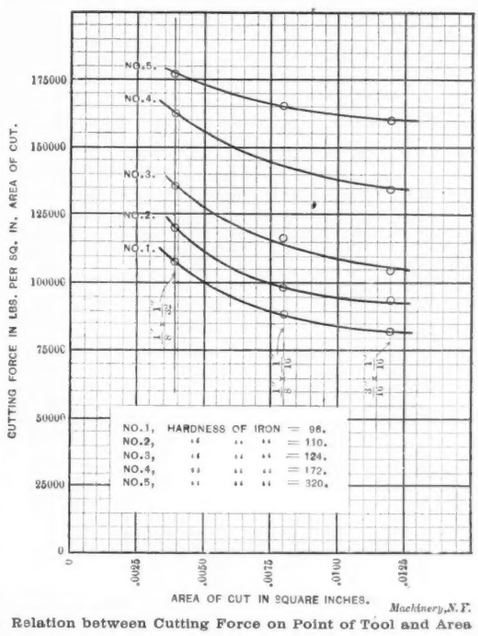


Fig. 3. Relation between Cutting Force on Point of Tool and Area of Cut.

II. The Cast Iron Test Pieces.

In order that the results of the tests might be of general application, it was advisable that the cast-iron test pieces be the

product of several commercial foundries. Several manufacturers throughout the State agreed to furnish sample test pieces representing the grade of cast iron used in their respective foundries. A standard size of test piece was therefore decided upon, and blue prints and patterns of it sent to the different manufacturers. The outer diameter is 9 inches, the maximum the lathe will swing over the carriage, and 27 inches long. This test piece was made hollow for several reasons. A solid test piece becomes soft toward the center and is more likely to contain blow holes. Test pieces of small diameter become springy and consequently produce inaccuracies in the results. The high angular velocity necessary with small diameters is also undesirable. Some other test pieces not conforming to the standard were used, however.

A comparative hardness test was made on all samples, comparison being made with a standard piece of soft cast iron of equal density throughout, the chemical analysis of which is as follows:

Combined Carbon...	= .147%	Manganese	= .33 %
Graphite	=5.03 %	Sulphur	= .07 %
Silicon	=2.35 %	Phosphorus	=1.06 %

The hardness of cast-iron or any other metal as indicated by a drill test is probably as fair an indication of the particular quality of the metal that affects the cutting speed as is obtainable by any process in use at the present time. This hardness test is in itself a cutting-speed test in which the cutting speed is not varied, but is held constant and the rate of feed allowed to vary, the cutting speed and rate of feed in all probability bearing some constant relation to each other. The tests were made with a drill press on the spindle of which

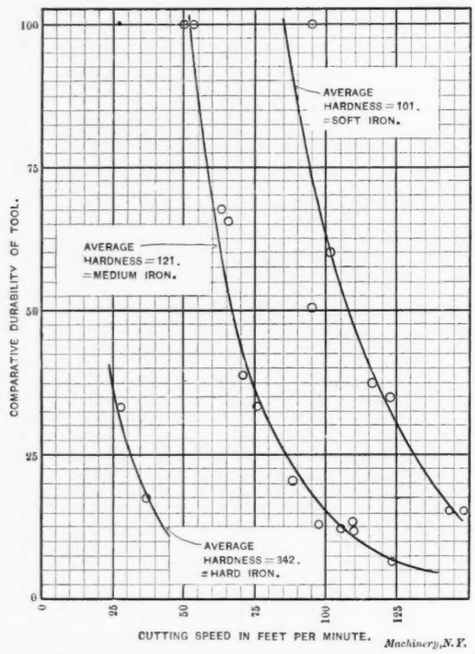

AVERAGE HARDNESS = 101. = SOFT IRON.
AVERAGE HARDNESS = 121. = MEDIUM IRON.
AVERAGE HARDNESS = 342. = HARD IRON.
COMPARATIVE DURABILITY OF TOOL.
CUTTING SPEED IN FEET PER MINUTE.
Machinery, N.Y.

Fig. 4. Variation of Durability of Tool for Different Speed and Grade of Iron.

a constant load of 312 pounds was applied by means of the weighted lever. With the spindle rotating at a constant speed of 87 revolutions per minute, the rate of feed of the drill in inches per minute was measured, readings being taken for every ⅛ inch of depth drilled. The drill used in these tests was a Morse standard ½-inch twist drill ground to an angle of 62½ deg. As, however, there was some liability of variation in the sharpness of the drill, thus affecting its rate of feed, a uniform piece of cast iron was first drilled into, readings taken, and then the test made on the test piece. A comparison was thus always made with this same piece of cast iron, eliminating any small variation in the sharpness of the drill. Thus, in one test the rate of feed is about .174 inch per minute, while in drilling the standard cast iron, the rate of feed is about .595 inch per minute. The hardness is thus expressed by the ratio $\frac{.595}{.174} \times 100 = 342$. The hardness of the standard cast iron is expressed by 100.

III. Details of the Tests.

Apparatus.—The apparatus used in conducting the tests consisted mainly of a high-speed lathe deriving its power from a two-phase induction motor by means of belting and a countershaft, the power required being measured by a polyphase wattmeter. The lathe was a Pratt and Whitney high-speed lathe with a gear box head-stock, taking a maximum length of 3 feet 9 inches between centers and a diameter of 9 inches over the carriage. The lathe has cone gears from which power is transmitted either direct to the spindle or through back gears, making 8 changes in speed. The feed mechanism is positive with 8 changes also.

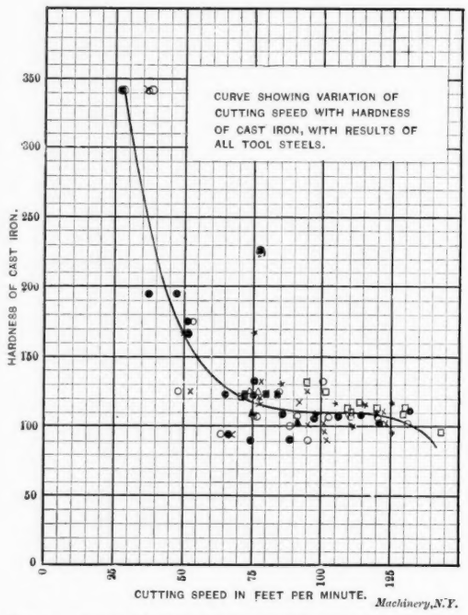

CURVE SHOWING VARIATION OF CUTTING SPEED WITH HARDNESS OF CAST IRON, WITH RESULTS OF ALL TOOL STEELS.
HARDNESS OF CAST IRON.
CUTTING SPEED IN FEET PER MINUTE.
Machinery, N.Y.

Fig. 5. Curves showing Proper Cutting Speeds of Iron of Varying Hardness

The power was transmitted to the lathe by means of a 4-inch double belt from the 12-inch friction clutch pulley of the countershaft. The countershaft in turn was driven through a 37-inch pulley by a 4-inch single belt from the motor. The motor is on an adjustable base, allowing changes of the motor pulley to be made without changing the length of the belt. In the tests, pulleys ranging from 6 to 12 inches in diameter were used, making possible with the 8 changes of speed on the lathe proper, 56 changes for every diameter of work. As the diameter of the test piece decreased, it was thus possible to keep the speed of the cut constant within very small limits.

Procedure in Making the Tests.—In the preliminary trials the skin was first removed to bring the test piece to a uniform diameter throughout. This was discontinued in the later trials and a separate series of skin cut trials was run. The test piece having been made ready for the test, the tool to be used was placed in the tool rest in the position decided upon for all tools and trials, viz., at right angles to the work with the bottom edge of the tool horizontal and the cutting edge of the tool from ⅛ inch to ¼ inch above the center of the work, its exact position being recorded in the log. The diameter of the test piece was then accurately measured in several places and the average recorded in the log. The tool was then fed in by hand until the cutting edge just scraped the bottom of the groove left by the last turning. The graduated disk on the cross feed having been set at zero, with the tool in the above position, the cross feed was turned back a little, and the carriage moved to the right sufficiently for the tool to clear the test piece. The cross feed was then advanced until the graduated disk showed the required cut opposite the index mark. The longitudinal feed or traverse was then set in position and recorded in the log. The diameter of the work and the surface speed required during the trial being known, the size of the pulley to be used on the motor and the position of the driving gear necessary to give the required speed were obtained from a set of curves giving the speed for various diameters of work for each of the 56 changes obtainable. This

having been done, the lathe was started and the surface speed tested with a Warner cutmeter. When the right conditions were finally attained, the lathe was stopped on a full cut, the revolution counter set at zero, the lathe cleared of chips, and the test started. After the expiration of the trial, which occurred either at the time of failure of the tool or at a specified time limit, the tool was withdrawn and the lathe run light under the same conditions of speed as in the trials, in order to observe the electrical horse-power exerted by the motor under these conditions. All the cuttings were then collected, weighed and recorded in the log.

Description of Methods Adopted for Measuring the Force Required in Cutting.—During the trials readings were taken at regular intervals of the total electrical watts input in the motor, while cutting, and after the tool had been withdrawn, with the lathe running light. The difference between the electrical horse-power with the tool cutting and with the lathe running without the cut should give the net horse power required for cutting, and if this be multiplied by 33,000 and divided by the cutting speed, we obtain the force required for cutting in pounds. In thus figuring, we assume that the lost horse-power of the drive remains constant from no load to full load. To determine whether or not this was the case, a Prony brake was placed on the cast-iron test piece, as shown in Fig. 2. This could be made to offer the resistance otherwise produced by the cutting tool, and this resistance could be measured at the end of the brake arm by observing the reading on the scale beam of the platform scales.

IV. Summary of Results.

Variation of Cutting Force with Area of Cut.—The effort exerted by the tool in cutting was determined as explained in Part III. The horse power lost in driving the lathe and countershaft was deducted from the total horse power used during the trial, the difference being the net horse power required for cutting. This was reduced to foot-pounds per minute, and divided by the cutting speed, giving the force exerted. The figures so obtained were reduced to pounds per unit area of cut, and plotted as ordinates upon a base of area of cut in Fig. 3. The curves show that the cutting force was not directly proportional to the area of cut, but decreased as the area increased, and that the average cutting force varied from 50 tons per square inch for soft cast iron to 85 tons per square inch for hard cast iron.

Variation of Durability of Tool with Cutting Speed.—An entirely arbitrary standard of durability was established as follows: A tool whose cutting edge was worn away .002 inch after an hour's use was considered perfect, its durability being expressed as 100. The ratios of the durability of any other tools to the standard will then be the inverse of the ratios of their rates of wear to the rate of wear of the standard.

In Fig. 4 are shown the curves which represent the relation between the durability of the tool and the cutting speed. These are important curves. Each curve represents a different hardness of cast iron. Referring to the middle curve, which is for cast iron of medium hardness, it will be seen that a cutting speed of 50 feet per minute is satisfactory, the durability being 100. If the speed is increased very materially, the durability decreases quite rapidly. It is evident that for each hardness of cast iron, the cutting speed allowable for a maximum durability exists where the vertical line indicating cutting speed is tangent to curves similar to those drawn.

Variation of Cutting Speed with the Hardness of Cast Iron.—The curve shown in Fig. 5 represents the advisable cutting speed on cast iron of varying hardness. This curve represents the result of all the tests of the different steels tested. This curve shows: (a) that any of the steels tested can remove very hard cast iron at a rate of 25 feet per minute; (b) that all of the steels tested begin to wear rapidly at speeds a little above 125 feet per minute. Between these two points the relation between a safe cutting speed and the hardness of the cast iron seems to be definitely expressed by the curve It would seem that cast iron of medium hardness, 100 to 120, could be cut at 125 feet per minute just as readily as at 70 feet per minute, so far as any injury to the tool is concerned. It must be remembered that this curve does not take into account the effect, on the cutting speed, of the variation in the area of cut; the experiments from which the curve was plotted were in all cases those in which the cut was very nearly ⅛ inch depth of cut by 1-16 inch feed, so that there is but a slight variation in the area of cut in all of the experiments. From the curve of Fig. 5 we find the cutting speed given in the table below to be applicable to the grades of iron manufactured by the different companies sending test pieces. In order that any company may make use of the curve shown in this figure, it will be necessary simply to determine the average hardness of its cast iron, as explained elsewhere, and where the horizontal line representing this hardness cuts the curve, the possible safe cutting speed may be read on the scale below. This curve should prove useful to various manufacturers.

Allowable Cutting Speeds for Grades of Cast Iron used in the Tests.

Average Hardness Test Pieces.	Allowable Cutting Speed.	Average Hardness of Test Pieces.	Allowable Cutting Speed.
101.8	132.0	103.1	132.0
110.7	118.0	132.0	63.0
109.3	120.0	343.0*	28.0
112.7	90.0	175.2	48.0
138.1	60.0	136.3	60.0

* Ferro-steel.

(*d*) Generally speaking, all the steels tested proved equally effective. It is very evident that there are great possibilities ahead for high-speed steels. Before realizing their full benefit however, certain advances must be made. Heavier machine tools must be built. The capacity of the motors and power plant must be increased. Special hardening furnaces with temperature measuring devices must be available. More must be known concerning the chemical and physical properties of the various steels.

PENNSYLVANIA RAILROAD SYSTEM LOCOMOTIVE TESTS.*

One of the chief features of the railroad exhibit at the Louisiana Purchase Exposition was the elaborate testing plant of the Pennsylvania Railroad System where eight locomotives of various types, four freight and four passenger, were exhaustively tested during the exposition period, as follows:

No. 1. Pennsylvania R. R., consolidation type, simple, wide firebox.

No. 2. Lake Shore & Michigan Southern R. R., consolidation type, simple, with wide firebox.

No. 3. Michigan Central, consolidation type, cross-compound, wide firebox.

No. 4. Atchison, Topeka & Santa Fe, Santa Fe type, tandem compound (decapod with trailer).

No. 5. Pennsylvania R. R., Atlantic type, 4-cylinder balanced compound (De Glehn).

No. 6. Atchison, Topeka & Santa Fe, Atlantic type, 4-cylinder balanced compound.

No. 7. Hanover Locomotive Works, Atlantic type, 4-cylinder balanced compound, with superheater.

No. 8. New York Central & Hudson River R. R., Atlantic type, 4-cylinder, balanced compound.

The plan, scope and details of the testing plant and of the tests were presented to the public from time to time in the form of pamphlets, and now the complete account of the work has been published in book form, together with comparisons and conclusions and a summary of conclusions. That the volume is one of exceedingly great value goes almost without saying. The following is the summary of conclusions of the work, which it will be seen gives in small compass facts of much significance:

Boiler Performance.

1. Contrary to a common assumption, the results show that when forced to maximum power, the large boilers delivered as much steam per unit area of heating surface as the small ones.

2. At a maximum power, a majority of the boilers tested, delivered 12 or more pounds of steam per square foot of heat-

* The Pennsylvania Railroad System Tests and Exhibits at the Louisiana Purchase Exposition. 733 pages, 6 x 9 inches, 817 cuts and folding plates and about an equal number of indicator and dynamometer diagrams and plottings of observations. Published by the Pennsylvania Railroad System and for sale by D. L. Newhall, purchasing agent, P. R. R., Philadelphia, Pa. Price, $5.00.

ing surface per hour; two delivered more than 14 pounds; and one, the second in point of size, delivered 16.3 pounds. These values expressed in terms of boiler horse power per square foot of heating surface are 0.34, 0.40 and 0.47 respectively.

3. The two boilers holding the first and second place with respect to weight of steam delivered per square foot of heating surface, are those of passenger locomotives.

4. The quality of steam delivered by the boilers of locomotives under constant conditions of operation is high, varying somewhat with different locomotives and with changes in the amount of power developed, between the limits of 98.3 per cent and 99.0 per cent.

5. The evaporative efficiency is generally maximum when the power delivered is least. Under conditions of maximum efficiency, most of the boilers tested evaporated between 10 and 12 pounds of water per pound of dry coal. The efficiency falls as the rate of evaporation increases. When the power developed is greatest, its value commonly lies between limits of 6 and 8 pounds of water per pound of dry coal.

6. The observed temperature of the fire-box under low rates of combustion lies between the limits of 1,400 degrees F. and 2,000 degrees F., depending apparently upon characteristics of the locomotive. As the rate of combustion is increased, the temperature slowly increases, maximum values generally lying between the limits of 2,100 and 2,300 degrees F.

7. The smoke-box temperature for all boilers, when worked at light power, is not far from 500 degrees F. As the power is increased, the temperature rises, the maximum value depending upon the extent to which the boiler is forced. For the locomotives tested, it lies in most cases between 600 and 700 degrees.

8. With reference to grate area, the results prove beyond question that the furnace losses due to excess air are not increased by increasing the area. In general, it appears that the boilers for which the ratio of grate surface to heating surface is largest are those of greatest capacity.

9. A brick arch in the fire-box results in some increase in furnace temperature and improves the combustion of the gases.

10. The loss of heat through imperfect combustion is in most cases small except as represented by the discharge from the stack of solid particles of fuel.

11. Relatively large fire-box heating surface appears to give no advantage either with reference to capacity or efficiency. The fact seems to be that the tube heating surface is capable of absorbing such heat as may not be taken up by the fire-box.

12. The value of the Serve tube over the plain tube of the same outside diameter, either as a means for increasing capacity or efficiency, was not definitely determined.

13. The draft in the front end for any given rate of combustion as measured in inches of water, depends upon the proportions of the locomotive and the thickness and condition of the fire. Under light power, its value may not exceed an inch, but it increases rapidly as the power is increased. Representative maximum values derived from the tests lie between the limits of 5 and 8.8 inches.

14. Insufficient openings in the ash pan and the mechanism of the front end, especially the diaphragm, are shown by the tests to lead to the dissipation of considerable portions of the draft force.

The Engine.

15. The indicated horse power of the modern simple freight locomotive tested, may be as great as 1,000 or 1,100; that of a modern compound passenger locomotive may exceed 1,600 horse power.

16. The maximum indicated horse power per square foot of grate surface lies, for the freight locomotives, between the limits of 31.2 and 21.1; for the passenger locomotives, between the limits of 33.5 and 28.1.

17. The steam consumption per indicated horse power hour necessarily depends upon the conditions of speed and cut-off. For the simple freight locomotives tested, the average minimum is 23.7. The consumption when developing maximum power is 23.8 and when under those conditions which proved to be the least efficient, 29.0.

18. The compound locomotive tested, using saturated steam, consumed from 18.6 to 27 pounds of steam per indicated horse power hour. Aided by a superheater, the minimum consumption is reduced to 16.6 pounds of superheated steam per hour.

19. In general, the steam consumption of simple locomotives decreases with increase of speed, while that of the compound locomotives increases. From this statement it appears that the relative advantages to be derived from the use of the compound diminish as the speed is increased.

20. Tests under a partially opened throttle show that when the degree of throttling is slight, the effect is not appreciable. When the degree of throttling is more pronounced, the performance is less satisfactory than when carrying the same load with a full throttle and a shorter cut-off.

The Locomotive as a Whole.

21. The percentage of the cylinder power which appears as a stress in the draw-bar, diminishes with increase of speed. At 40 revolutions per minute, the maximum is 94 and the minimum 77; at 280 revolutions per minute, the maximum is 87 and the minimum 62.

22. The loss of power between the cylinder and draw-bar is greatly affected by the character of the lubricant. It appears from the tests that the substitution of grease for oil upon axles and crank pins increases the machine friction from 75 to 100 per cent.

23. The coal consumption per dynamometer horse power hour, for the simple freight locomotive tested, is at low speeds not less than 3.5 pounds nor more than 4.5 pounds, the value varying with running conditions. At the highest speeds covered by the tests, the coal consumption for the simple locomotives increased to more than 5 pounds.

24. The coal consumption per dynamometer horse power hour, for the compound freight locomotives tested is, for low speeds, between 2.0 and 3.7 pounds. Results at higher speeds were obtained only from a two-cylinder compound, the efficiency of which under all conditions is shown to be very high. The coal consumption per dynamometer horse power hour for this locomotive at the higher speeds increases from 3.2 to 3.6 pounds.

25. The coal consumption per dynamometer horse power hour for the four compound passenger locomotives tested, varies from 2.2 to more than 5 pounds per hour, depending upon the running conditions. In the case of all of these locomotives, the consumption increases rapidly as the speed is increased.

26. A comparison of the performance of the compound freight locomotives with that of the simple freight locomotives is very favorable to the compounds. For a given amount of power at the draw-bar, the poorest compound shows a saving in coal over the best simple which will average above 10 per cent, while the best compound shows a saving over the poorest simple which is not far from 40 per cent. It should be remembered, however, that the conditions of the tests, which provide for the continuous operation of the locomotives at constant speed and load throughout the period conveyed by the observations, are all favorable to the compound.

27. It is a fact of more than ordinary significance that a steam locomotive is capable of delivering a horse power at the draw-bar upon the consumption of but a trifle more than 2 pounds of coal per hour. This fact gives the locomotive high rank as a steam power plant.

28. It is worthy of mention that the coal consumption per horse power hour developed at the draw-bar by the different locomotives tested presents marked differences. Some of these are easily explained from a consideration of the characteristics of the locomotives involved. Where the data is not sufficient to permit the assignment of a definite cause, there can be no doubt but that an extension of the study already made will serve to reveal it.

* * *

For most ordinary purposes, Prof. Carpenter recommends babbitt metal as being a satisfactory bearing metal, but for more severe conditions he advises a mixture of 50 per cent aluminum, 25 per cent zinc and 25 per cent tin.

NEW METHOD OF FINISHING PISTON RINGS.

A new method of finishing spring piston rings, that is, rings turned larger than the cylinder bore, has been invented and patented (No. 793,276) by Mr. Warren Chambers of Toronto, Ontario, formerly of Beloit, Wis. It was first tried in the works of the Fairbanks-Morse Co., of Beloit, on the piston rings of gas engines. The scheme is illustrated in the accompanying cuts, Figs. 1, 2 and 3, and consists of grinding the periphery of a ring under essentially the same conditions that affect it when in the cylinder of the engine, but before describing it fully it will be of interest to briefly review the conditions affecting the manufacture of piston rings as generally followed.

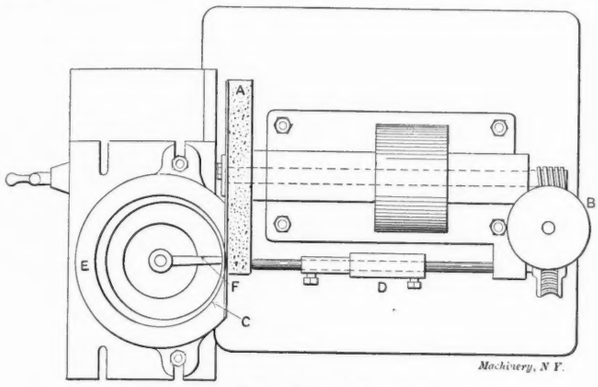


Fig. 1. Plan View of Piston Ring Grinder.

Every mechanic knows that a ring which is turned larger than the bore of the cylinder, whether it be of uniform thickness, bored eccentric or cast to a theoretical tension curve on the inside surface, will not have a uniform tension or bearing on the surface of the cylinder bore until it has been filed or scraped to fit, or let run until it wears itself to a bearing. That the last named method is not good practice is quite obvious. The efficiency of a gas engine to a large extent depends upon the compression it is possible to obtain and if the rings have imperfect bearing, the efficiency under the first working test must be below the standard. Moreover the leak may never take up entirely on account of the destructive scoring effect of the escaping gases on the cylinder walls. To file and scrape a piston ring to a good bearing is a laborious and expensive job, and is one that is usually commercially impractical on account of the keen competition in this field of manufacture.

One method of obtaining an approximately close fit is to spring the ring down nearly to the cylinder diameter and

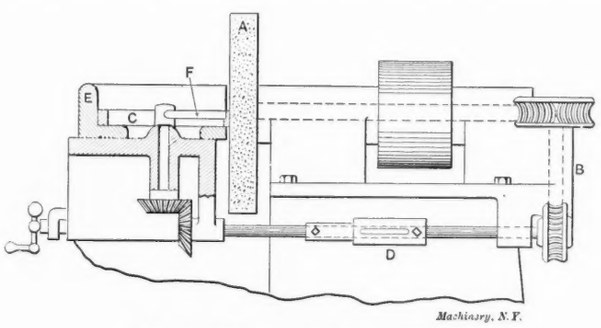


Fig. 2. Driving Mechanism of Grinder.

clamp it between collars or flanges; then having removed the form a light cut is taken over the periphery. This method is a decided improvement over the "fitting by hand" method but it is by no means a perfect job, for it will leak, the simple reason being that taking a cut over the surface, which necessarily takes off more stock in some places than in others, changes the tension of the ring and the distribution of the metal so that as soon as the clamp collars are removed it alters shape. To prove this put it in the cylinder, when daylight will invariably be seen between the ring and the cylinder bore. Or, a better test is to spring it down to the size it was last turned to, and after removing the form to test it in a universal grinding machine. The ring will be found to "run out" no matter how many times the operation is repeated. In a series of experiments along these lines on 6-inch rings they were found to be run out when the operation was repeated not less than twelve times. Of course the error was diminished at every grinding but the principle remained the same.

Some manufacturers make their piston rings eccentric with the inside bore, which is left rough for cheapness of production and also to get the benefit of the scale remaining inside; the scale improves the elasticity of the ring and lessens the liability of breaking or distortion when sprung over a solid piston. This method does not produce a perfect bearing ring, although some of the evils of the turned eccentric ring, finished all over, are undoubtedly mitigated thereby.

After going over the various methods of manufacture Mr. Chambers came to the conclusion that there is only one practically perfect method of finishing piston rings, and that is to grind them under the same conditions of shape and tension that they are subjected to in working, and the machine shown was designed with this object in view. It consists of a frame carrying an emery wheel *A* and a form *E* in the center of which latter is a revolving finger *F* driven by suitable worm reduction gearing *B* from the emery wheel spindle. The form *E* is bored smaller than the diameter of the ring to be ground, being of the same diameter as the cylinder, to which it corresponds; various sizes are provided to suit the sizes of the rings to be ground. The table carrying *E* is adjustable relative to the emery wheel, the driving gear shaft having a telescopic sleeve at *D*. One side of the form is cut off tangentially so that about ⅜ inch of, say, a 5-inch ring is exposed

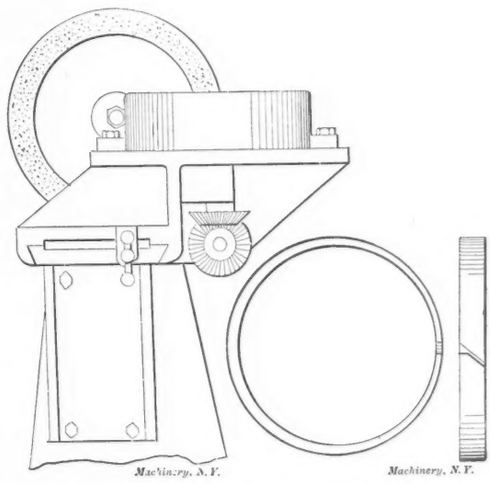


Fig. 3. Front Elevation. Fig. 4. Design of Ring used.

to the emery wheel. The ring, of the type shown in Fig. 4, is sprung into the form with the finger *F* engaged in the cut. The finger slowly revolves the ring while the grinding wheel removes the high spots and these only. As the grinding proceeds the ring changes shape conforming more and more closely to the form until it reaches a practically perfect bearing therein. It makes no difference what the character of the material composing a ring is, its width, hardness or defects such as blowholes, spongy spots, etc.; it will grind to an exact bearing in any case because the ring is free to adjust itself to the changing condition due to the removal of the high spots. Naturally, therefore, Mr. Chambers, who has had many years practical experience in the manufacture of piston rings, believes that he has discovered the only sure way of eliminating the one serious trouble in the manufacture of gas engines. A piston ring finish that will get a "stay-over-night" compression, is produced in this machine easily and cheaply by ordinary labor, and the machine is adapted to a wide range of sizes of rings. It is not confined of course to the production of gas engine piston rings but any kind or style of piston ring required may be produced equally as well. This machine makes it possible to produce chilled piston rings, and, in fact, was designed with this object in view.

When piston rings are to be ground in place in a solid piston so as to avoid the distortion incident to springing them into

the grooves, the form *E* is made deep enough to receive the whole piston and the driving finger *E* is removed. The piston is revolved by suitable pins which drive both the piston and its rings, the piston being drilled to receive the driving pins.

* * *

A DISCUSSION OF THE TAYLOR SYSTEM OF SHOP MANAGEMENT.

A feature of the February reunion of the A. S. M. E. held at the society headquarters on the evening of February 27, was the reading of a paper presented by James M. Dodge, of the Link Belt Engineering Co. He described the introduction and present operation of the Taylor system in the shops of his concern. The paper was written in a clear and bright style, which kept the audience interested and at times amused.

Mr. Dodge described the conditions which led to the change in the administration of the Link Belt Engineering Co.'s shops. Reports had come to them from time to time of the remarkable work being done at the Bethlehem Steel Works by the Taylor-White steel, and after watching performances of tools treated by this process and after painfully convincing himself and his tool dresser that the steel had really an efficiency hitherto undreamed of, he eventually obtained a license for its use. Most of the work it had to do in their own shops, however, was in turning cast iron, and it was soon discovered that as originally made the tools, in this material, fell far short of their performance when used on armor plate and nickel-steel forgings at the steel works. A long and costly series of experiments was then entered into, from which finally resulted a steel which gave as good results on cast iron as the original steel did on the more fibrous metals. This was the introduction of the Link Belt Engineering Co. to one of the most important phases of the new method of shop management, namely, the careful scientific investigation of the factors that have to be considered to produce superior commercial results.

It was soon seen that other features in the management of the shop in which much pride had been taken, had lost some of their luster when compared with the standard set by the new steel. For instance, in figuring piece work rates, which had been hitherto done by guess work on the part of "guessers" who were supposed to be as good as any in the country, it was realized that a little mistake one way or the other made more difference when a man was making 200 pieces a day than it did when he was making 50. On realizing the truth of this fact, it was concluded that a scientific rate-setting department was needed. The preceding changes increased the output of the concern to such an extent as to necessitate the altering of the store-room system to meet the demands of the increased business. The receiving room then showed up to such poor advantage in comparison with the stock room that it next succumbed to the wave of reform. The increase in the amount of business was again found to be so great as to overtax the memories of the men who had been responsible for looking out for the details of putting the work through the shops, and finally the entire administration of the plant was so changed as to concentrate the routing of the product in the hands of a separate department, which laid out the work for every man and machine in the establishment.

Defining the new method, Mr. Dodge said: "The Taylor system as I know it, is not a method of paying, a mere question of foremanship, the selection of a pink ticket or a blue ticket in the store room, the specific ruling of a ledger, nor the use of the slide rule universally, or even the use of high-speed steel, or the question of electric or belt drive, or any other one of details which might be multiplied almost indefinitely; it is much broader, better and more far-reaching than any of its parts, however excellent they may be; it is simply an honest, intelligent effort to arrive at the absolute truth in every department, be it agreeable or disagreeable; to let tabulated and unimpeachable fact take the place of individual opinion; to develop team play to its highest possibility; to make it impossible for an incompetent laggard to remain intrenched in his position, whether he be of greater or less importance; to secure to every individual of an organization just recognition of his personal utility and worth; to root out prejudice and make students of us all, with the success of the organization paramount to individual preferment; and to make men work, not harder, but to better advantage."

At the close of the address a number of men rose to their feet and began to ask questions such as: "To how small a shop can the system be applied?" "Are there any varieties of work to which it cannot be successfully applied?" "Can deliveries by this method be successfully figured in advance?" At this juncture Mr. Taylor himself was discovered in the rear of the hall, whence he was persuaded to come forward and give the desired information. The remainder of the meeting was taken up with a rapid fire of question and comment, in the course of which many interesting and valuable suggestions were presented by Mr. Taylor, whose remarks were listened to by the audience with evident appreciation. In regard to the question of the minimum size of the shop to which the system is applicable, he referred to a recent installation in a Philadelphia establishment which employs about 120 men. This he considered to be the minimum limit for a concern doing work of a varied character and was only possible in this case because the product was such that, as the improvements began to take effect, the rate of production could be increased to keep the maximum number of machines at work. On work of an elementary and routine nature a much smaller number of men could use the system to advantage.

Referring to the question as to the varieties of work to which it was safe to apply the system, he considered that there was practically no limit to its usefulness in this direction. In shops where there is much of such work done the grinding of parts to limits of 0.001 inch or, in some instances, 0.00025 inch could be figured on as accurately as the removal of surplus stock from a 13-inch gun forging. Mr. Taylor admitted that the pattern shop presented the toughest proposition in this respect and did not think it advisable to lay out the work of the patternmaker beforehand, as is generally done for the lathe and planer operator. He believes, however, that even this might come within the range of practicability in a place where patternmaking is done on a sufficiently large scale.

Other points were discussed, such as the mental attitude necessary on the part of the management and the employees for the successful working of the system, and the possibility of difficulty with labor unions. Mr. Taylor threw valuable light on all these questions and kept his hearers interested until a late hour.

* * *

A JOKE ON THE OLD MAN.

A. P. PRESS.

We got a joke on the "Old Man" last week that was too good to keep. A joke on one of the boys is all right, but when the "Super" bites it off, it is better still.

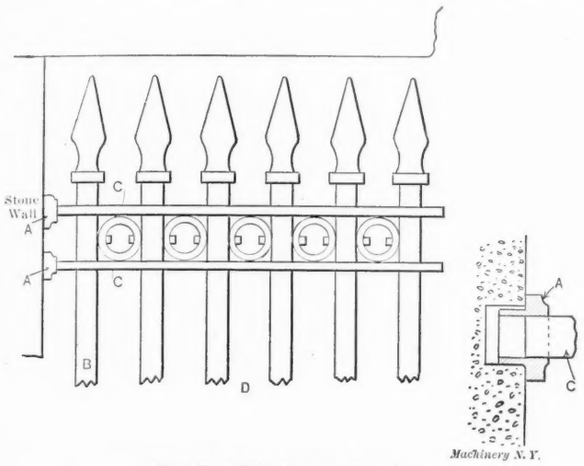
Down at one end of the press-room is a drop-press driven by a rope-lifter. The countershaft is up near the wall, and one end runs through the partition, and the driving pulley is on the other side. Bill was doing a lot of flat dropping and he was making the hammer fly (it was a piece work job). The "Old Man" came into the room and stood watching him. Bill run off a lot, shut off the power and went away from the drop. The "Old Man" did not notice there was a driving belt, in fact he couldn't see it, as it was on the other side of the partition. He went down the room, went up to the drop and tried to raise the hammer. It weighs about 150 pounds, and it wouldn't raise worth a cent. He put his foot in the loop at the end of the rope, put his whole weight on it and drew it up about a foot, let it drop and went out. The next day he came in and went up to the foreman and said, "That man Bill is the strongest man I ever saw. He can handle that 150-pound hammer like a toy. Ain't he worth a quarter more a day." "Sure thing," said the foreman. "Put in a slip," said the "Old Man," "and I'll pass it." Bill got his quarter raise, but the joke leaked out and it has cost Bill more than the quarter per day to keep the boys quiet about the joke. Bill is afraid that if the "Old Man" gets word of it, his cake will be dough.

* * *

The quality of the alloy steels used for making permanent magnets has been so improved that they are now made of the horseshoe form which will hold suspended ten times their own weight.

FASTENING FOR BANK WINDOW GRATING.

The impression of strength, solidity and safety which every bank and trust company strives to cultivate in the public mind is undoubtedly enhanced by the brave display of heavy bolts, bars, gratings, "unbreakable" vaults, etc., which are a prominent feature of most such concerns. If it were not so there would be less money wasted on them for to the simon pure burglar much of this stuff must seem as vanity. When a trust company takes quarters in a modern office building up go the ponderous gratings over the windows as a matter of course. The accompanying cut shows how the grating of one



How Bank Windows are Guarded.

trust company's offices in New York are secured. While the idea is good as a mechanical expedient it has the obvious fault of being as easily removed as erected. The grating *D* is formed of ten massive bars 2 inches diameter set in four lateral bars, *C*, the two upper ones only being shown. The lateral bars are secured in the wall by the bushings *A* which fit in square pockets drilled into the stone. The enlarged view at the right shows the construction clearly. It is plain, of course, that the bars *C* could be little longer than the width of the window opening but the bushings in effect lengthen them and fix them to the stone walls. When the holes were all drilled a few minutes' work sufficed to set the massive grating and drive the bushings home. And by the same token a few minutes' active work with a hammer and wedge would loosen them.

* * *

PATENT PROTECTION.

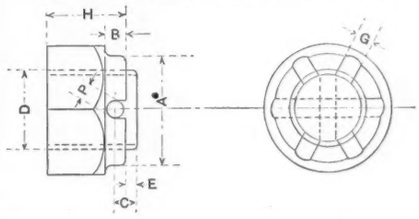
We frequently hear the complaint that patents do not protect or that a patent is about as good as a summons to a lawsuit, etc. The question in effect has been often asked: "Why cannot the present patent condition be remedied so that if an inventor is once granted a patent he will know that he is secure in its enjoyment for its term of life, the same as if he has been granted a lease for a certain tract of real estate, etc." The answer is, of course, that a patent is not intended to be a guarantee of novelty or of prior right under the present interpretation of patent law. It is merely a publication under the seal of the United States that the inventor has devised certain improvements in mechanics or other lines which, so far as the patent office examiners are able to determine, do not conflict with other publications (patents) along the same lines. What the rights of any invention, published in the manner prescribed, are, must necessarily be determined by the courts, for it is outside the natural or possible province of the patent office to determine these rights. That this is only justice and in the natural order of things will be quite obvious to any one who looks at the subject broadly. Take, for example, some device in common use in an industry of unlimited scope or of a sequestered nature. An inventor in another part of the country developing the same industry might invent an identical process, machine or tool, and apply for a patent with no knowledge on his part or of anyone in the patent office of its prior use. Now, after the patent was granted to this inventor, if it were not possible to adjudicate the conflicting rights great injustice might be done to those already using the invention to whom it might be a very old device—known to their forefathers, perhaps. The patent examiner may be regarded as an editor; he sizes up an application for a patent to the best of his ability and compares it with the mass of devices of a similar nature, but with the fullest care in examination there is likely to be a conflict of claims, impossible to avoid. Of course the patent office does decide the conflicting rights of inventors in cases of interference, that is, where two or more inventors ask for a patent on the same idea at the same time, but this is done entirely to determine the matter of relative priority, and in no way affects the standing of the granted patent to the world at large.

* * *

STANDARD CROWN NUTS WITH LOCK.

Of all the nut-locks invented the simple hole through the bolt above the nut with a split cotter has been the most popular on machinery, especially locomotives. It has the defect, however, of not being a positive nut-lock so much as a provision against loss of the nut should it work loose, but the same principle of construction is often used as a positive lock, the hole being drilled through the nut and bolt so that when screwed home the cotter can be put through both and split so as to hold the nut securely in place. This construction is objectionable, however, because it requires the parts to be assembled, marked and afterwards drilled. An improved form is the "crown" nut, of which Mr. A. P. Sharp, Williamsport, Pa., contributes the accompanying table of dimensions, with cut; it is made with the top turned to a smaller diameter and slotted with three grooves across the face. The cut and table are practically self-explanatory and little more need be said. It will be readily understood that, with two holes through the bolt, at right angles, and three slots across the face of the nut, at 60 degrees divergence, a hole and slot must coincide at every one-twelfth revolution. Hence, there can never be any great difficulty in getting a positive locking position and at the same time having the nut tightly screwed home. Of course neatness requires that the holes through the bolt be

TABLE OF DIMENSIONS FOR CROWN NUTS.



H = HEIGHT OF STD. NUT

D & H	B	A	G	E	C	P IN DIA.	LENGTH	DRILL
.5	.15625	.6875	.125	.0625	.15625	.125	.875	.125
.625	.1875	.875	.15625	.0625	.15625	.156	1.25	.15625
.75	.1875	1.	.15625	.0625	.15625	.156	1.25	.15625
.875	.25	1.25	.21875	.0625	.25	.203	1.5	.21875
1.	.25	1.375	.21875	.125	.25	.203	1.75	.21875
1.125	.375	1.5	.25	.125	.375	.25	1.75	.25
1.25	.375	1.75	.25	.125	.375	.25	2.	.25
1.5	.5	2.	.375	.125	.4375	.375	2.5	.375
1.75	.5	2.125	.375	.125	.4375	.375	2.5	.375
2.	.5	2.5	.375	.125	.4375	.375	2.75	.375
2.5	.625	3.	.5	.125	.5	.5	3.5	.5
2.75	.625	3.25	.5	.125	.5	.5	3.75	.5

Machinery, N. Y.

drilled closely approximating the position required when the nut is screwed down but a variation of 1/32 or even 1/16 inch or more, depending on the size, above the ideal position will not affect its action. The crown nut is largely used on agricultural machinery, being usually cast in malleable iron for this purpose. The table, however, applies to standard machine nuts only.

* * *

An aluminum solder patented in England August 3, 1905, is composed of 6 parts tin; 30 parts zinc; 1 part lead; and 1 part aluminum. Resin is used for a flux.

LETTERS UPON PRACTICAL SUBJECTS.

CALCULATIONS INVOLVING THE STOPPING AND STARTING OF LOADS.

Editor MACHINERY:

The accompanying table was compiled to furnish ready data for engineering calculations involving the stopping or starting of live loads and the stresses resulting. It is based on the equation

$$\text{Force} = \frac{\text{weight} \times \text{velocity}^2}{2 \times \text{gravity} \times \text{space}}$$

which is readily derived from the equation for kinetic energy, as follows:

$$E = \tfrac{1}{2} \times \text{mass} \times \text{velocity}^2,$$

where mass = weight ÷ gravity = w/g.

Substituting, $E = \dfrac{w\,v^2}{2g}$.

Dividing this by s, the space traveled, we get for the force,

$$F = \frac{w\,v^2}{2gs}$$

The quantities in the main part of the table give the fraction of the weight of a body necessary to stop it in the distance shown in the vertical column headed "space traveled." Thus, a body moving 2,000 feet a minute requires a force of 1.736 times the weight of body to stop it in a distance of 10 feet. If it is stopped by sliding friction with a coefficient of 0.174, it will slide 100 feet. At 600 feet a minute a body will move six feet against a force of 0.261 times its own weight. Quantities below the heavy line are for coefficients of friction of less than 0.18, which is the coefficient for iron on steel.

Applications.

(1) Spring Bumpers.—A body weighing 3,000 pounds and moving 300 feet a minute is to be stopped by a helical spring with but six inches compression. The average load on the spring is 3,000 × 0.782 = 2,346 pounds, the initial load being = 0 and the final load = 4,692 pounds.

(2) End Thrust on Cranes due to Stopping or Starting a Trolley with Load.—(This is used in the calculation for bending or runway girders, the bending on columns, and the stability and side bracing for gantry cranes.) A 20,000-pound trolley and load moving 500 feet a minute stops in a distance of six feet. The end thrust produced is 0.181 × 20,000 = 3,620 pounds. If stopped in two feet the force would be 0.543 × 20,000 = 10,860 pounds.

In the same way the table gives the lateral forces producing bending on the crane girders, due to stopping and starting. The force required to stop the girders is uniformly distributed, while for the live load it is concentrated.

(3). A body weighing 1,200 pounds is given a velocity of 800 feet a minute while traveling nine feet. The force required is 1,200 × 0.309 = 367.2 pounds.

(4). A car moving at 1,500 feet a minute (about 17 miles an hour) will slide 50 feet with wheels locked if coefficient of friction is 0.195. To stop it in 25 feet by using sand on the rails, the coefficient must be raised to 0.391 feet.

(5). The time elapsed in (4), without sand, is 50 ÷ 750 minutes = 4 seconds. With sand the time would be 2 seconds.

Cleveland, O. L. H. MILLER.

LINING CONNECTING RODS.

J. V. N. Cheney.

Editor MACHINERY:

It frequently happens that proper care is not exercised in fitting up connecting rods in the shop to get them in line, or one might say to get them to "point" right. Owing to the brasses not being bored out at right angles to the rod, when they are put on the pins, they will naturally bind, with the result that they run hot and pound. The writer has had considerable experience in this line, and has found many examples of this bad practice, both on locomotive and stationary engines. For example, the wrist-pin brasses of a 36 x 60-inch engine could not be made to run cool; it was, of course, due to lack of care on the part of the erector, to see that both ends of the rod pointed right before putting it up for good. In this case it was necessary to remove the wrist-pin weighing about 125 pounds—a task of no small proportions and away from the shop, where tools were scarce. Fortunately, there was a good sized bolt hole tapped into the inside end, so by a combination of bolt, strap and heavy sledge hammer, the pin was started loose. The sketch shows, exaggerated, the position the rod was in when disconnected from the crank-pin. To make it point right the brasses were filed, and scraped at the points indicated, a matter requiring several trials before the proper pointing was attained.

Sometimes it happens that the crank, or disk, is not true with the shaft, or the pin is out of square with the crank.

J. V. N. CHENEY was born in Bradford, Vt., 1857. He commenced work on machinery in Colt's Armory, Hartford, at the age of 14, and has continued in that line of work up to the present time. His term of apprenticeship was served with the N. Y., N. H. & H. R. R., at Hartford, Conn.; he has since been employed by the N. Y. & N. E. R. R.; Illinois Central; South Side "L," Chicago; Masonic Temple, Chicago; G. J. Railway and U. S. Government. His positions have been those of locomotive engineer, locomotive foreman, chief engineer, round house foreman and erecting engineer.

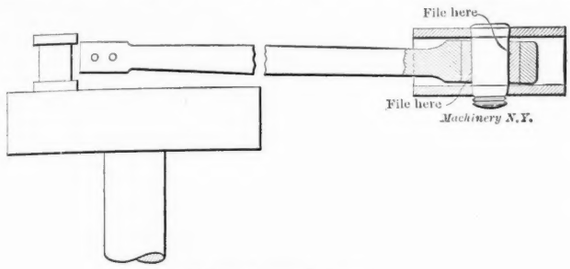
TABLE GIVING FORCES REQUIRED TO STOP MOVING BODIES.

SPACE TRAVELED	VELOCITIES IN FEET PER MINUTE																	
	100	200	300	400	500	600	700	800	900	1000	1100	1200	1500	2000	2500	3000	4000	5000
0′ 6″	0.087	0.348	0.782	1.390	2.171	3.125	4.25	5.65	7.35	8.68	10.50	12.50	19.54	34.74	54.25	78.20	139.0	217.1
1′ 0″	0.0434	0.174	0.391	0.695	1.085	1.563	2.125	2.772	3.53	4.34	5.26	6.25	9.77	17.36	27.12	39.10	69.5	108.6
2′ 0″	0.022	0.087	0.195	0.348	0.543	0.782	1.063	1.385	1,758	2.17	2.625	3.125	4.885	8.68	13.55	19.53	34.75	54.3
3′ 0″	0.014	0.058	0.130	0.232	0.363	0.521	0.785	0.925	1.172	1.445	1.750	2.082	3.255	5.79	9.40	13.02	23.17	36.21
4′ 0″	0.010	0.043	0.098	0.174	0.273	0.391	0.531	0.694	0.880	1.085	1.312	1.573	2.442	4.34	6.78	9.77	17.36	27.15
5′ 0″	0.009	0.035	0.078	0.139	0.217	0.313	0.425	0.555	0.704	0.868	1.050	1.250	1.954	3.475	5.42	7.82	13.89	21.75
6′ 0″	0.007	0.029	0.065	0.116	0.181	0.261	0.354	0.463	0.586	0.724	0.876	1.042	1.628	2.895	4.52	6.52	11.57	18.10
7′ 0″	0.006	0.025	0.056	0.099	0.155	0 223	0.304	0.397	0.503	0.621	0.750	0.893	1.395	2.480	3.875	5.58	9.93	15.53
8′ 0″	0.0054	0.022	0.049	0.087	0.136	0.195	0.266	0.347	0.440	0.543	0.657	0.782	1.222	2.171	3.390	4.89	8.68	13.58
9′ 0″	0.0048	0.019	0.043	0.077	0.121	0.174	0.236	0.309	0.391	0.483	0.584	0.695	1.085	1.930	3.013	4.34	7.72	12.07
10′ 0″	0.0043	0.0174	0.039	0.069	0.109	0.156	0.213	0.277	0.354	0.435	0.525	0.625	0.977	1.736	2.712	3.92	6.94	10.86
25′ 0″	0.0017	0.007	0.0156	0.0278	0.0434	0.0625	0.085	0.111	0.145	0.174	0.210	0.250	0.391	0.695	1.085	1.563	2.78	4.35
50′ 0″	0.0009	0.0035	0.0078	0.0139	0.0217	0.0315	0.0435	0.0555	0.0704	0.087	0.105	0.125	0 195	0.348	0.543	0.782	1.39	2.175
100′ 0″	0.0004	0.0017	0.0040	0.0070	0.0108	0.0156	0.0213	0.0277	0.0352	0.043	0.053	0.063	0.098	0.174	0.271	0.392	0.695	1.086
500′ 0″	0.0001	0.00035	0.0008	0.0014	0.0022	0.0032	0.0044	0.0056	0.0070	0.0087	0.0105	0.0125	0.0195	0.0348	0.054	0.078	0.139	0.2175

Machinery, N.Y.

In these cases pointing of the rod is even more important than where they are true with one another. The writer attributes his success with rods to this feature, though it is a good practice to be careful that the fillets are entirely clear, as their wearing will cause the brasses to heat and give trouble.

It frequently happens that the bushings in a solid ended rod are worn, but not enough to warrant throwing them away,



Lining Connecting-rods.

and are allowed to run longer than they otherwise would. A cheap and convenient way to repair these bushings, is to remove them from the rod; then, with a thin cutter, or if a milling machine is not available, a cutting-off tool in the shaper, a slot is cut through the bushing to allow it to close. With a thin iron liner of the proper thickness, press the bushing again into the rod, pin if necessary, and bore out to size required. The writer has seen many rods repaired in this manner, doing as well as with new bushings. J. V. N CHENEY.

South Portland, Me.

COPPER CHUCKING STRIPS FOR LATHE CHUCKS.

Editor MACHINERY:

I frequently have a number of duplicate pieces finished on one side and outside and inside diameters to finish on the other face. In place of using loose strips of copper or brass between the chuck jaws and the finished surface, I take strips of copper or brass about 4 inches long and from ⅛ to ½ inch wide, according to the distance the work acts back in the jaws, so that the copper will not extend quite as far back as the work. I bend these strips so as to fit closely around the outside step of the jaw. I have two or three sets of different widths for different kinds of work. They last a long time and remain in place while changing from one piece to another. Beside the amount of time they save in putting loose strips in place for each piece of work, they save an immense amount of time in chucking, as they fit themselves to the grooves in the jaws and after the first piece is accurately centered the duplicates will need only a slight change of pressure on the two marked jaws to bring them to center.

I have a number of rings of different diameters accurately faced, one of which I place behind any piece that will not set back against the faceplate of the chuck and tap the piece back against this to true it up after I bring it to center. By having the strips of copper narrow there is no shoulder to prevent the work from tapping back solidly against the ring.

Schenectady, N. Y. ROBERT MAYHEW.

THE LATHE AS A SPECIAL MACHINE.

Joseph M. Menegus.

Editor MACHINERY:

A large number of machines have been invented to meet the requirements of modern machine shop practice for the rapid production of interchangeable pieces; and, for the most part, they are good machines which do just what is claimed for them. Years ago, when one of these machines was installed in a machine shop, it was a source of curiosity and comment. Men would stop to look at it with interest and the boys would look at the man who ran it with contempt, for he could produce, perhaps, five times as much work as he would do on the old lathe. To-day whole departments are equipped with one type of these special machines, and they are coming more and more into favor, for they are indeed wonderful dividend producers. But these machines cost

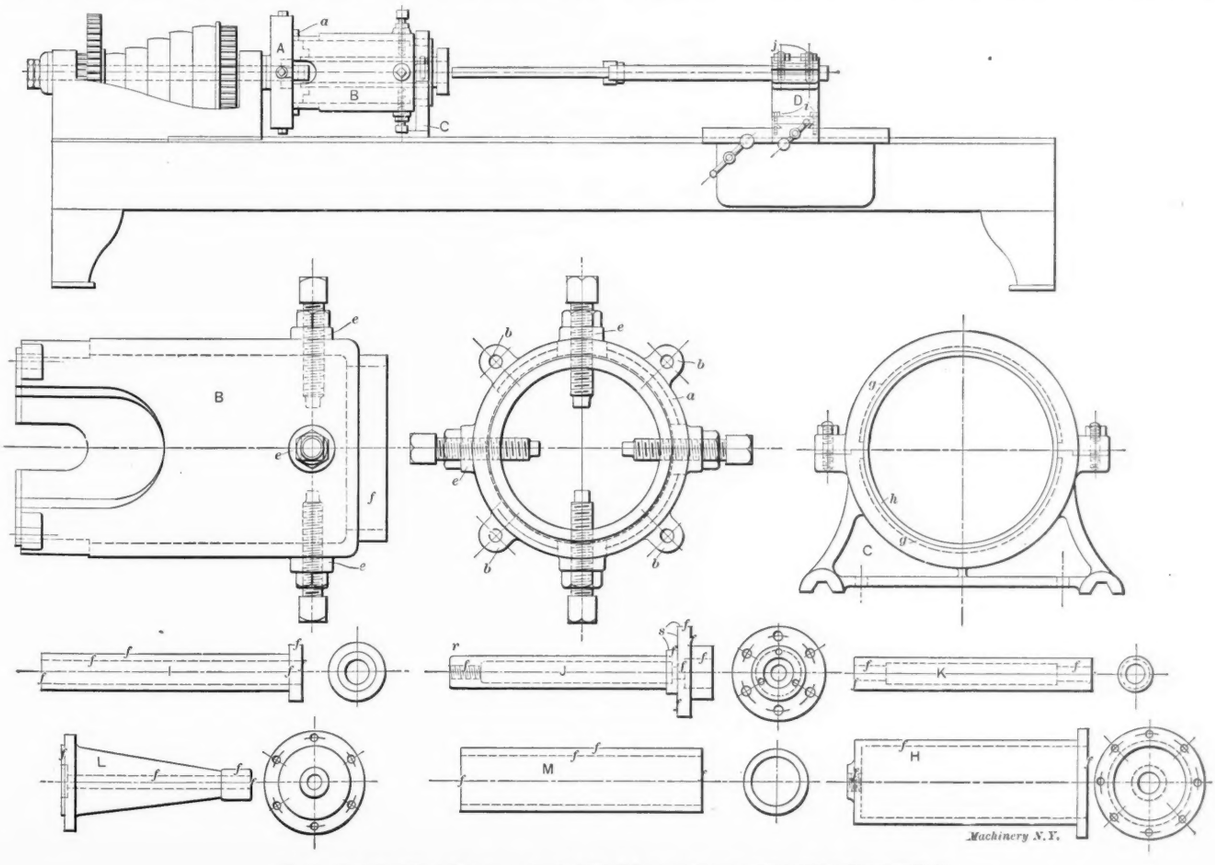


Fig. 1. A Lathe Rigged up as a Boring Machine, and some of the Work Done with it.

piles of money, and if the large manufacturing concerns with almost unlimited capital can afford to buy them, small and medium-sized shops often cannot. Furthermore, a small shop may not have enough work to keep the machine going, and in this case it is a bad investment. One of the principal aims of a successful foreman of one of these shops should be to specialize his machines as far as possible, and do this economically, which is not an easy task by any means.

The accompanying cuts show a lathe transferred into a special machine and some of the tools and attachments. The lathe should be strongly built and should have a hollow spindle; if it has a solid spindle it should be bored out, but if it will not stand boring a heavier spindle should be made, and the cone pulley, gears and bearings rebored to suit the new spindle. A universal chuck, *A*, is provided, which is bored to receive bushings to guide the boring bars. The casting *B*, which I call a supplementary chuck, has a ring attachment, *a*, which fits on the left end of *B*, and is provided with four lugs, *b*. These are used to bolt *B* onto the chuck *A*. Piece *B* has four openings, three of which are only large enough to allow the carriage by means of the bolts *i* and is bored in place to the same size as the boring-bars. The holder is split on one side and is provided with a feather; the bars are tightened in place by means of the screws *j*. *F*, Fig. 2, shows the kind of boring bars used. The part *m* fits the bushing in *A*; and *n*, the bar-holder *D*. The feather ways *o* are for the feather in the bar-holder. A number of boring tools, for boring the smaller holes, are made as shown at *p*. For facing surfaces of small diameter grooved tools as shown at *G* can be used for roughing and similar tools without grooves for finishing. The tool-holder *H* is for boring holes of larger diameter. It is made of cast steel and can hold either boring or facing tools. Several of these tool-holders are made so as not to disturb the tools when they are set for a certain job, and are to be used again in the near future. A number of reamers can be made as shown at *O*, and taps can be constructed in the same way, where the tapping has to be done.

H, *I*, *J*, *K*, *L* and *M*, Fig. 1, show some of the pieces that can be successfully machined on the special lathe; the marks *f* denote finishing. Pieces *J* and *H* require tapping. Piece *J*,

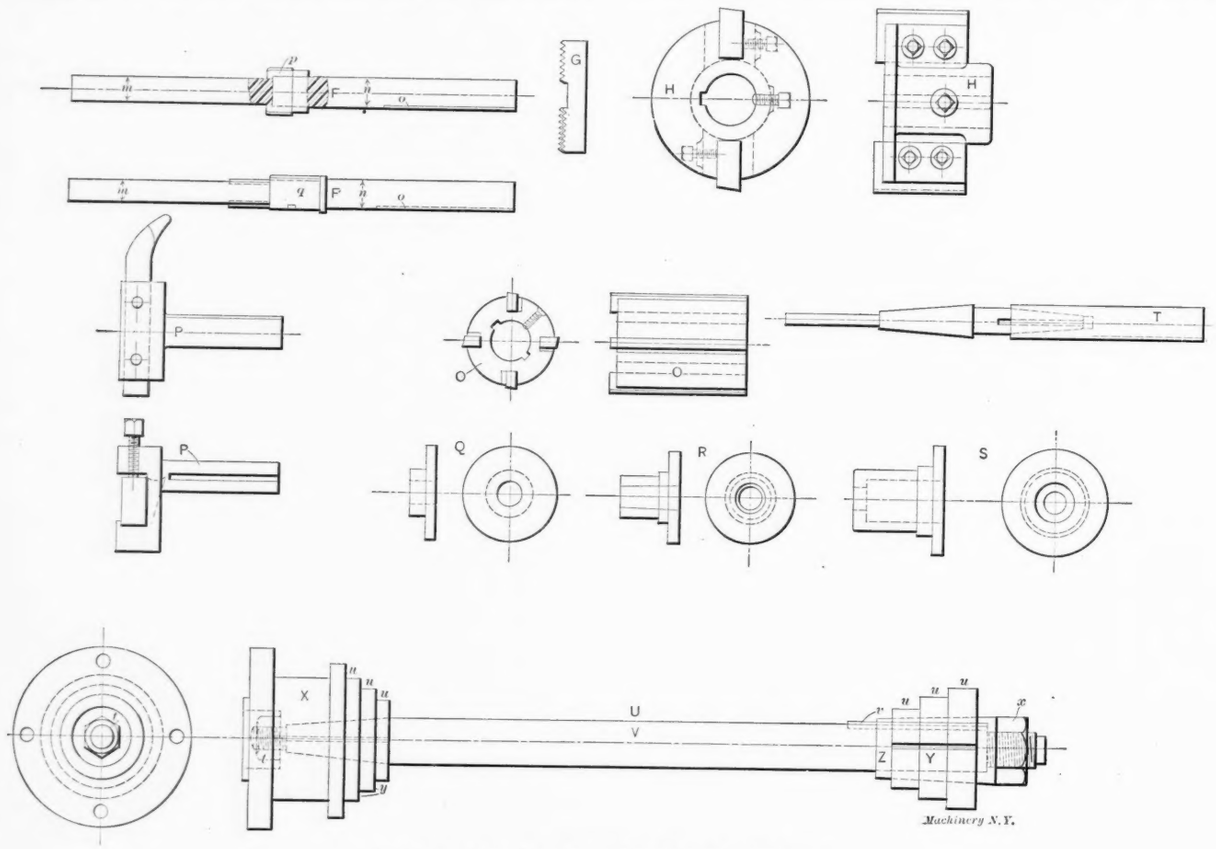


Fig. 2. Tools used in a Specially Equipped Boring Lathe.

the jaws to pass and one is larger in order to allow the hands of the operator to pass in. The four bosses, *e*, are each tapped for a tempered steel screw that has a lock-nut to prevent it from turning after the piece to be bored has been centered. The part *f* is carefully turned and on this part is fitted a special steadyrest, *C*, whose construction can be readily seen in the sketch. It is made of cast iron, in two pieces, fitted and bolted together and cast with receptacles, *g*, to hold babbitt or other anti-friction metal. The steadyrest is put on the machine and the babbitt metal bored in place to the same diameter as *f* of piece *B*.

The cross-slide is removed from the old lathe, and the boring bar-holder *D* put in its place. This holder is bolted on which is a stuffing-box and valve stem nut, can be machined at one operation. It is chucked at *r* and after it has been bored, tapped and faced, it is turned and faced at *s*. To do this the screws *i* have to be removed, and the bar-holder *D* used as a cross carriage, using the tool-holder *P*, which fits the bar-holder *D*. Piece *L* also requires the use of this tool-holder to face and turn down its fitting. If there is not enough work of this kind to keep these machines and tools busy, the machine can be used for boring and facing short pieces, as shown at *Q*, *R* and *S*, removing piece *B* but using the same bars, tools and tool-holders with the addition of bar *T*, which is bored to receive taper reamers and taps, these being guided by the same bushing as the boring-bars.

For turning linings *M* or sleeves *I* on the outside a mandrel, as shown at *U*, is very useful. The steel bar *V* is tapered at one end to fit the piece *X*, which latter is fitted and bolted on a faceplate, and is counterbored for the nut *t*. Piece *X* is turned off at the steps *u* to the same diameter as the bore of the linings. The expansion ring *Y* is also turned of the same diameter as the bore of the linings, and is bored tapering.

JOSEPH M. MENEGUS was born in Venice, 1873. As a boy he served a term of apprenticeship with his father in Venice, and five years ago he finished a course of mechanical engineering with the International Correspondence Schools of Scranton. He has been employed by W. G. Armstrong & Co., Mitchell & Co., F. Mondini & Co., H. R. Worthington Hydraulic Works, C. D. Mosher (naval architect), Lidgerwood Manufacturing Co., etc. His positions have been those of machinist in all the different branches of the trade, general foreman, draughtsman and constructing engineer; he has lately been associated with two inventors, developing their ideas, and designing new devices and machinery, the construction of which he will superintend.

The taper piece z fits the bar V closely and is guided by means of a feather, v; it expands ring y when the nut x is tightened. The finished faces of the linings go against the steps of the piece x. The linings are driven against the pressure of the cut by the feather v and by friction against the faces of X and Y.

These are only a few of the pieces that can be machined and a few of the tools that can be used. A larger variety of tools can be made to meet different requirements.

Los Angeles, Cal. J. M. MENEGUS.

METHOD OF FINDING PITCH ANGLE OF BEVEL GEARS.

Editor MACHINERY:

Recently I had to find the angle of pitch for a pair of bevel gears and as it cost me some time to figure them, I think the method will be of some interest to the readers of MACHINERY.

One of our customers sent us a pair of bevel gear patterns as per sketch, with 40 and 16 teeth, and an angle of shaft of

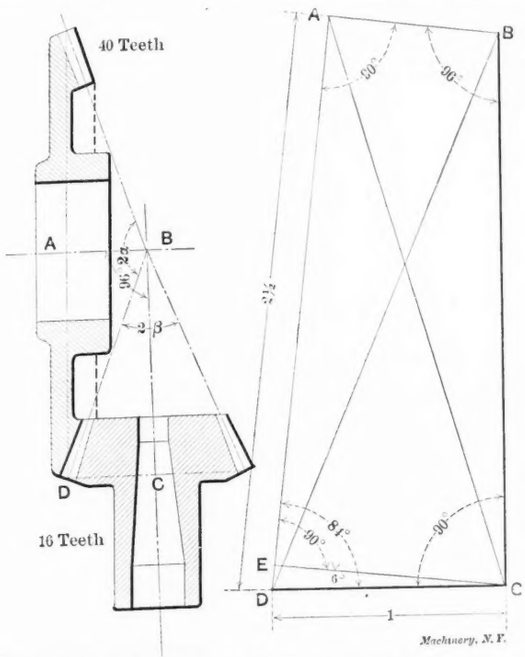


Fig. 1. The Gear the Customer Ordered.

Fig. 2. Diagram showing Solution of Problem.

96 degrees without any other terms, and wanted to have same manufactured on the so-called Warren gear cutter. I found the pitch angle as follows:

A quadrilateral, Fig. 2, was drawn having two adjacent sides in the proportion of 1 to 2½ (the same as the gears) and in which the opposite angles DAB and DCB are right angles, these angles corresponding to those indicated by the same letters in Fig. 1. Now, it will be observed that the diagonal DB is a side common to both right triangles DAB and DCB. Hence a circle, having its center on the line DB, can be circumscribed around the quadrilateral which will pass through the vertices of the four angles D, A, B and C. With this construction it is apparent that angle $ACD = ABD = \alpha$, or one-half the included pitch angle of the larger gear.

$$\cos 6^\circ = \frac{EC}{1}; \quad EC = \cos 6^\circ = 0.994522$$

$$\sin 6^\circ = \frac{DE}{1}; \quad DE = \sin 6^\circ = 0.104529$$

$$\tan ACE = \frac{AE}{EC} = \frac{AD - DE}{EC} = \frac{2.5 - 0.104529}{0.994522} = \frac{2.395471}{0.994522} = 2.4087$$

Angle $ACE = 67^\circ\ 27'$.

Angle $ACE + ECD = ACD = ABD = \alpha = 67^\circ\ 27' + 6^\circ = 73^\circ\ 27'$.

Angle $DBC = \beta = 96^\circ - \alpha = 96^\circ - 73^\circ\ 27' = 22^\circ\ 33'$.

Angle of pitch of 40 teeth gear $= 2\alpha = 146^\circ\ 54'$.

Angle of pitch of 16 teeth $= 2\beta = 45^\circ\ 6'$.

It would be simpler but not so exact to use the graphic method. Draw angle $ADC = 180^\circ - 96^\circ = 84^\circ$ with the use of a Brown & Sharpe protracter; make $DA = 2\frac{1}{2}\ DC$ and erect in A and C perpendiculars which meet together in point B; now connect B with D. The angles thus found, $ABD \times 2$, is the pitch angle of the 40-tooth gear and $DBC \times 2$ is the pitch angle of the 16-tooth gear. OTTO ECKELT.

Berlin, Germany.

[It is possible to obtain a simpler general expression of Mr. Eckelt's solution of the bevel gear problem. For, since $EC = DC \times \cos ECD$ and $DE = DC \times \sin ECD$, the following equation will be true:

$$\tan ACE = \frac{AD - DE}{EC} = \frac{AD - (DC \times \sin ECD)}{DC \times \cos ECD}$$

$$= \frac{AD}{DC \times \cos ECD} - \frac{DC \times \sin ECD}{DC \times \cos ECD}$$

If N = the number of teeth in the large gear, and n the number of teeth in the small gear, then will $\frac{N}{n} = \frac{AD}{DC}$; also we know that $\frac{\sin ECD}{\cos ECD} = \tan ECD$. Substituting these expressions in the above equation, we have

$$\tan ACE = \frac{N}{n \times \cos ECD} - \tan ECD.$$

$$\alpha = ACE + ECD$$

This makes a very convenient method of finding the pitch cone angle of two bevel gears, but it is scarcely any easier than using the formulas given in the Brown & Sharpe "Formulas in Gearing," or those given by Mr. Porter in the September (1905) issue of MACHINERY. Mr. Eckelt's way of approaching the problem is, however, new, so far as we are aware.—EDITOR.]

DRAW-IN CHUCK FOR ENGINE LATHES.

C. J. Shaw.

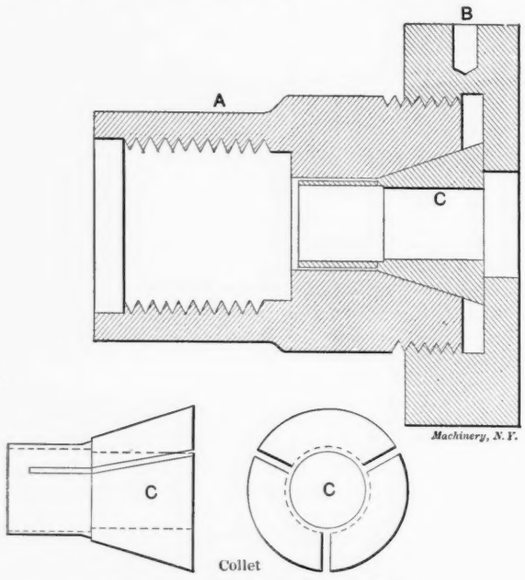
Editor MACHINERY:

The sketch shows a special chuck of the draw-in style which can be fitted to any lathe spindle, or can be made to fit a milling machine spindle. This chuck is used for round stock of ¼ to ¾ inch diameter, or the range can be made even greater by making bushings or collets to take larger stock. Cold rolled stock threaded to make studs can be held firmly and will run true on account of the tapered bushing centering itself when drawn in place by the binding collar. An advantage over the usual three or four-jawed chuck is, that when a piece of standard sized cold rolled stock or drill rod is to be threaded, or turned so as to leave a part of the original size on the finished piece, the 3- or 4-jawed chuck is sure to mar the piece more or less and time has to be taken also to adjust the jaws to get the stock to running true; with the chuck shown in the sketch there is no marring of the stock and no time taken in getting the piece to be machined to run true.

The sketch shows but one collet, but of course there has to be one for each size of stock used. The bushings should be case-hardened if made of soft steel or hardened and drawn if made of cast steel. After hardening they should be ground inside and the tapered part outside.

C. J. SHAW was born in Rochester, N. Y., 1878. In addition to a common school education, he studied mechanical drawing in an evening school and is now taking a course in mechanical engineering with the International Correspondence School. He served an apprenticeship with the W. P. Davis Machine Co., Rochester, N. Y., and has since worked for the Cadillac Motor Car Co., holding positions of machinist and tool-maker. His especial interest is experimental work and tool-making.

Part *A* is fitted to the lathe spindle on one end and is bored taper to receive the split bushings and threaded for the binding collar, on the other end. Part *B* is the binding collar, which, when screwed up against the bushing *C* compresses *C* and binds the work. Part *B* should be made of soft steel and



A Draw-in Chuck for the Engine Lathe.

case-hardened. A hole is drilled in the periphery to receive the nipple of a spanner wrench for tightening and loosening *B*.

Part *C* is the split, hardened and ground bushing. If thought advisable a key can be fastened in the clearance space in *A* and a slot milled in the bushings to fit the key to keep the bushings from turning when being either tightened or loosened.

When the saw cuts are made in the bushings to allow for compression, the saw should not quite cut clear through at the front end, but a little metal should be left in the cut to keep the parts from springing too much when hardening. After hardening, the metal left in the cut can be removed by grinding with a thin emery wheel or by striking on a thin drift which will go in the saw cut. C. J. SHAW.

Detroit, Mich.

The benzine will evaporate very quickly and leave the original in as good a condition as before print was taken. Care should be taken that too much benzine is not used as it might spot the original if blueprint solution were to be reached by any great quantity of benzine, although I have never experienced this difficulty even though I have made many prints by this method. R. F. KIEFER.

Sharon, Pa.

TO REMOVE INK LINES FROM TRACINGS.

Editor MACHINERY:

The writer has tried numerous methods for erasing ink lines from tracings, with the best results as follows: Place the part of the tracing, containing line to be erased, upon some hard substance, such as celluloid triangle, and run over it lightly with a razor edged knife; this leaves the cloth in sort of a rough condition, which will readily be taken hold of by a medium hard eraser. The tracing may then be smoothed down by using the rounded edge of the knife handle or its equivalent, and will then take the ink without causing the latter to run. CALVIN B. ROSS.

Springfield, Ohio.

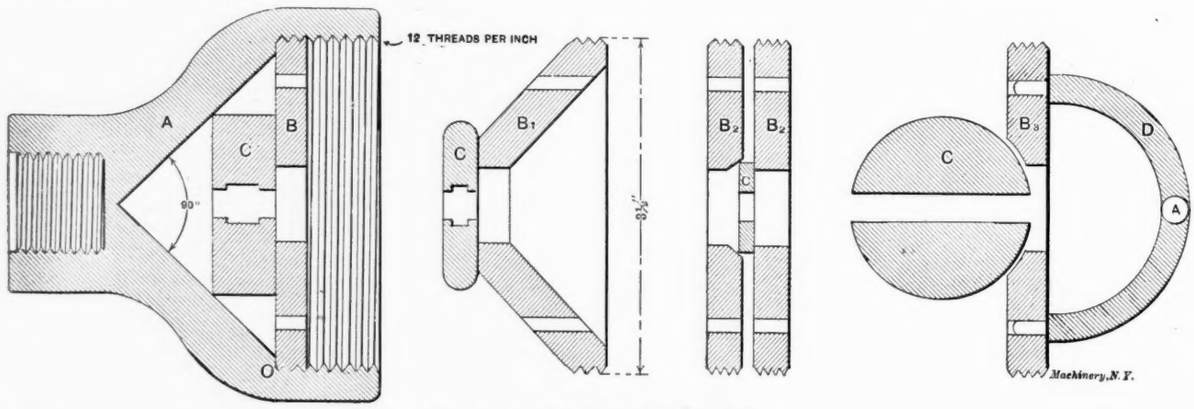
SELF-CENTERING CHUCK.

L. E. Muncy.

Editor MACHINERY:

I show herewith a sketch of a *real* self-centering chuck, which I made several years ago, and which may be of use to the readers of MACHINERY. I designed this originally for holding milling cutters after tempering, to grind the hole to size, but having it fitted to a 14-inch lathe on which I did my cutter grinding, I found it very handy many times on odd pieces which were required to be chucked very accurately. The chuck body *A* and follower plates *B* were made from cast iron, which with the spanner wrench *B* completed the outfit. Plate *B* could be reversed if necessary, shoulder *O* being faced true. Two plates, as B_2B_2 were used to bore out a thin washer to size. The plate shown at B_3 is used for boring a hole through the center of a ball, etc.

Syracuse, N. Y. L. E. MUNCY.



A Self-centering Chuck for the Engine Lathe.

TO MAKE BLUEPRINTS FROM BRISTOL BOARD ORIGINALS.

Editor MACHINERY:

Oftentimes a draftsman finds it advisable to make blueprints of cuts and drawings of which he may have a copy on Bristol-board, heavy drawing paper, etc. This is a long and tedious operation if conducted in the usual manner, but if the sheet to be printed is first given an application, or "coat," of gasoline or benzine, on the face side, then printed, the result will be better and more quickly obtained than by the ordinary way.

CHEAP SUCTION AND LEAD HOSE.

Editor MACHINERY:

Where hose is needed only for suction purposes or for leading liquid away where there is little pressure, as in pumping

L. E. MUNCY was born in the town of Cuyler, Cortland Co., N. Y., 1858. He served a term of apprenticeship with Cooper Bros., of Cortland, N. Y. He has worked for the Porter Manufacturing Co., Syracuse, N. Y., Rowley & Hermance, Williamsport, Pa.; C. E. Lipe, Syracuse, N. Y.; Orange County Foundry Co., Middletown, N. Y., and several others, in the various capacities of all-round shop workman, shafting turner, toolmaker, planer hand, lathe hand, floor hand, machine tool assembling shop foreman, etc. For the last five years his work has been the making of steel molds for "finishing castings" for the H. H. Franklin Mfg. Co., Syracuse, N. Y.

out bridge caissons, draining mines, etc., it is not worth while to pay for regular made two-ply seamless rubber hose, which, moreover, can only be made in short sections, because of the great cost and weight of the mandrels on which such hose must be made and vulcanized. The cheapest way is to sew up canvas duck on a Blake or similar sewing machine (two seams), and then, having wound galvanized steel wire on a mandrel of a diameter a very trifle greater than the internal diameter of the hose, to spring this in the latter, being sure to make the ends of the spiral fast to the couplings. The purpose of the spiral inlay is to keep the hose sprung out to the full diameter, and to prevent kinks. Where there is danger of excessive wear by dragging on the ground, the hose may be reinforced by an outer spiral or by a canvas jacket, although it will usually suffice to give only those points that are most subject to wear, such protection. When once this hose gets wet it is tight against the atmospheric pressure from without, and up to about two atmospheres (30 pounds per square inch) from within—always provided in the latter case, that the canvas will stand the bursting stress. Where there is much such stuff to make, it is better to order canvas in which the woof or filling is stronger than the warp, as the cross threads get the principal stress. If the canvas be tanned it will last longer. Such hose, without the inner spiral, is very much used for tank hose at railway watering points. When a tramp happens to cut a hole therein for the purpose of getting a drink, the loss is not so great as when this occurs with regular mandrel-made vulcanized rubber hose. The cost for such tank hose is about one-fifth that of the two-ply rubber.

Hanover, Germany. ROBERT GRIMSHAW.

PATCHING TIRES—A REMINDER OF THE DAYS OF THE THE WROUGHT IRON LOCOMOTIVE TIRE.

Editor MACHINERY:

The illustrations show a hard and what was always a rush job on roundhouse work during the era of wrought iron locomotive tires. A great deal of trouble was caused by flat spots developing in the tread of the tire, and to turn these spots out was not to be thought of unless the engine was in for general repairs. Under the circumstances it was a clear case

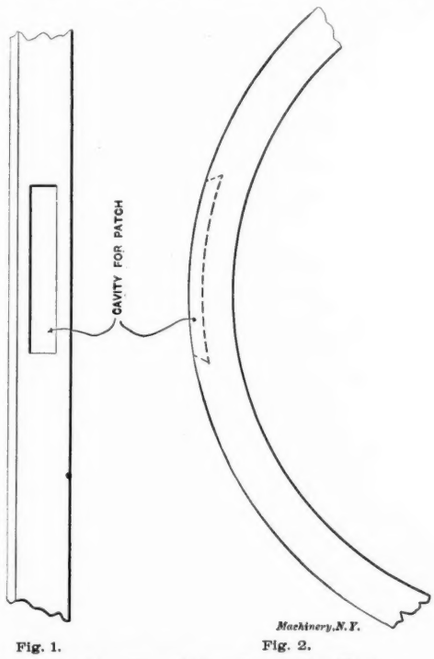


Fig. 1. Fig. 2.

Patching Wrought Iron Locomotive Tires.

of patching the tire. These low spots would sometimes be all of twelve inches long by about two inches wide. To make a seat for the patch we would in most cases use a ratchet and "tit" drill the width of the depression. The use of the drill saved us a great deal of chipping; the chipping was a hard job from the fact that in almost every case the job stood right up and down before us, there being no room to work by turning the wheel so as to bring the work on top. After drilling we would chip the cavity to the shape shown in Fig. 1 and dovetail the ends and sides as indicated in Fig. 2. The blacksmith would then forge a patch just a little longer and as wide as the cavity, and of a thickness to fill up in good shape. There was a chance here for the blacksmith to show some good judgment. When the patch was forged all right he would give it a bend endwise, making it shorter than the cavity. The patch was then heated a bright cherry red, brought to the job, put in and hammered vigorously into place with the ball pene of the hammer so as to force the patch under the dovetail along the edge. The tire having a tendency to cool the patch it took lively work as the cooling had to be followed up with the hammer to head off shrinkage. When it was in good and solid we chipped off the surplus to a template. Was it hard work? Yes; and it was always a stay-till-you-get-it-finished-job and it run well into the night too. Then it was put up wheel covers, couple up the tender, etc., but I was young then. W. DE SANNO.

Soldiers' Home, Cal.

AUTOMATIC TURRET WORK.

Paul W. Abbott.

Editor MACHINERY:

The accompanying sketches show a set of tools for making the piece shown in Fig. 1 in the automatic turret lathe. These pieces were to be made of cast iron finished all over, accuracy limit 1-64 inch, but it was necessary that the outside run dead true with the hole. The finish on the work had to be such that they would take a good polish without any filing or hand tooling.

Fig. 2 shows the casting of which this piece was made. The castings were made so that there would be plenty of stock to come off, for it is much more economical on work requiring a good finish to take off a generous amount of stock than to try and work just under this scale.

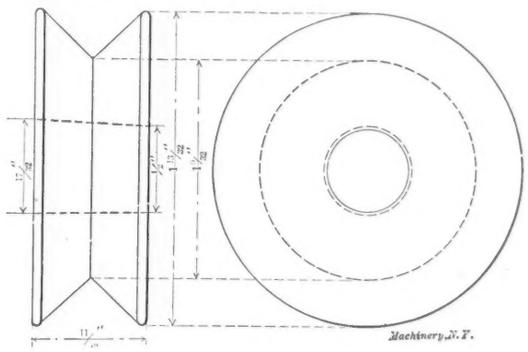


Fig. 1. Piece to be Made on the Turret Lathe.

The automatic was equipped with a three-jawed lever chuck made to take false jaws, and as we had never done any small work on this automatic it was necessary to make new jaws. Fig. 3 shows a duplicate of the slides on the chuck onto which

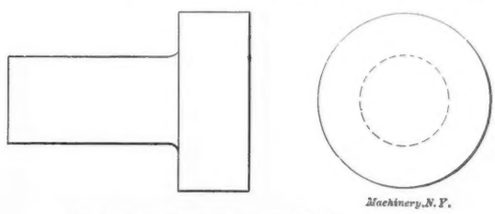


Fig. 2. The Casting from which Fig. 1 is Made.

the jaws bolt. This was used as a template, all the work on the jaws and boring fixtures being laid off from this template. The line *A* scribed on the template represented the center line

PAUL W. ABBOTT was born in Lowell, Mass, 1884. His education outside of the common school has been derived chiefly from home study and evening schools. He commenced work at the age of 14 in the Lowell Machine Shop and has remained there ever since, working his way up to his present position of toolmaker. His specialty is automatic turret tool-making and grinding.

of the chuck. The shoulder, *C*, locates the jaw on the chuck.

Fig. 4 is the boring fixture, being a false plate made to bolt onto one of the lathe faceplates. The dimension B_1 is the same as *B* on template. So with the holes laid off the same, it followed that the jaws drilled from the template and transferred to the boring fixture to be bored, and then to the chuck, ran practically true.

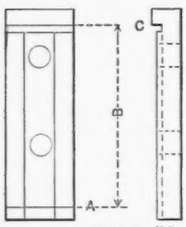


Fig. 3. Template for Machining False Jaw.

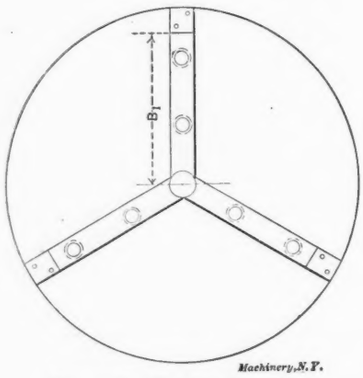


Fig. 4. The Chuck used.

The operations on the work are as follows:

First, turn over top and drill with combination tool held in turret, Fig. 5.

Second, form groove with circular forming tool held on the holder, Fig. 6, on back block on cross-slide. The forming tool was 2½ inches diameter and was bolted to the holder with a 1-inch bolt tightened with a 14-inch wrench. No trouble was experienced with tools slipping.

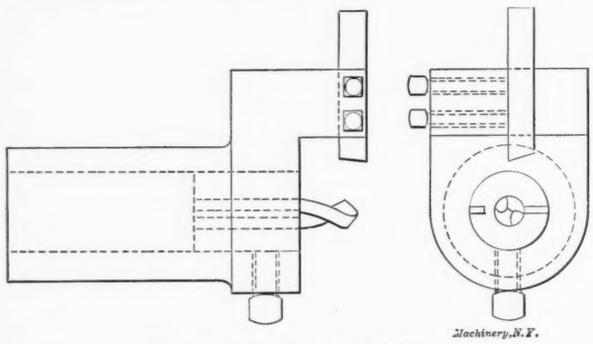


Fig. 5. Tool for Turning and Drilling.

Third, while the forming tool was cutting, the boring tool was advancing, starting to bore the instant forming tool had stopped cutting. Not being satisfied with anything in the line of an adjustable boring tool holder that I had seen, I designed the one shown in Fig. 7. The range of adjustment is wide and can be readily understood from the sketch. The boring

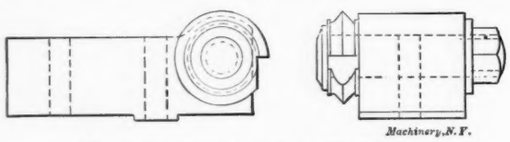


Fig. 6. Form Tool for Turning the Groove.

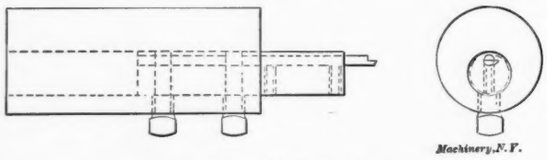


Fig. 7. Adjustable Boring Tool.

tool was made from ¼-inch drill rod, although larger stock could be used just as well with this same idea. This holder is not a costly one to make and fills the bill for easy adjustment and stiffness.

Fourth, squaring both sides and reaming. The squaring tools were in the front block, Fig. 8 on the cross-slide. The reamer was held in a floating holder in the turret. The reamer reams to depth and then stops; the squaring tools are cutting meanwhile. When the tools cut through to the hole the work stays on the reamer and the squaring tools back off. The reamer also backs off, carrying the piece on it. The operator removes shank of casting from chuck, puts in another casting, starts turret in and removes finished piece from reamer, thus completing operation.

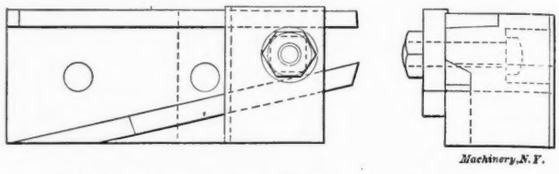


Fig. 8. Tool for Squaring the Sides and Cutting Off.

This set of tools was a complete success in every way. Time for one piece, 4½ minutes, 125 per day.

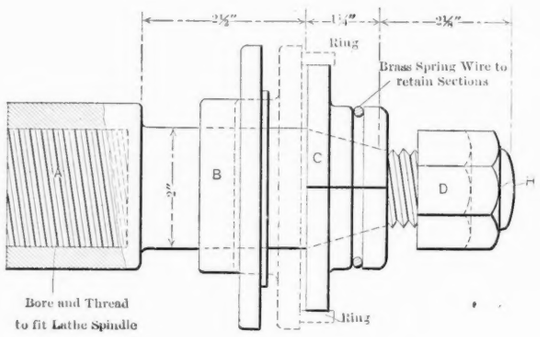
Lowell, Mass. PAUL W. ABBOTT.

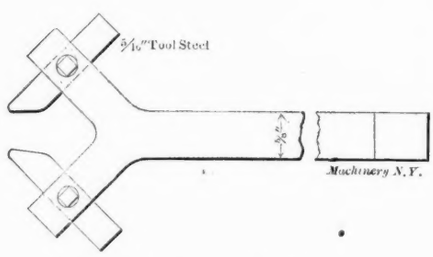
* * *

RING TURNING AND FACING FIXTURE.

Editor MACHINERY:

The cut shows a ring turning or facing fixture which I have found very useful. The device is a mandrel bored and threaded at one end to fit any lathe spindle desired; the mandrel is turned down for the sliding collar *B* which is used only for locating the ring squarely in position. The end of the mandrel is turned tapering and is threaded with 1¼ inch standard thread for the nut *D*. On the taper part is fitted the expanding part *C* which is a collar cut into three sections. These sections are held together by a brass spring wire fitted in a groove turned on the collar. Various sizes of these collars are made, one for each size of ring to be turned.





Ring Turning Fixture and Facing Tool.

To operate the device we first screw it onto the lathe spindle, and slide collar *B* up against *C*, then tighten up the nut *D* with the ring to be faced, in place butted against *B*. Then *B* is slid back out of the way. The dotted lines indicate the positions occupied by the ring and the collar *B* when setting the ring.

The lathe tool shown is used for facing, every ring being faced to exactly the same width and with parallel faces. It will be observed that the flange of *C* on which the ring is mounted is narrower than the ring in order to clear the lathe tools and that a boss is provided on *B* so that in setting the ring it will overhang slightly on that side.

GEO. W. SMITH, JR.

Marquette, Mich.

SHOP KINKS.

A DEPARTMENT OF PRACTICAL IDEAS FOR THE SHOP.
Contributions of kinks, devices and methods of doing work are solicited for this column. Write on one side of the paper only and send sketches when necessary.

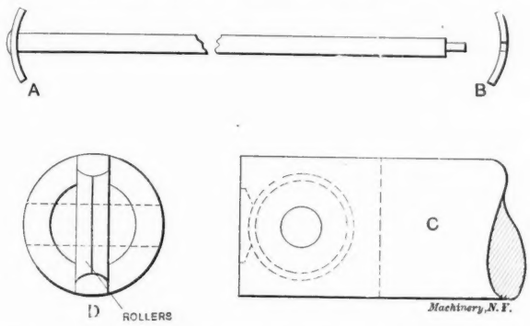
TO REMOVE BROKEN TAPS FROM BRASS OR COPPER.

To remove broken drills, etc., from brass or copper in which they have been broken off immerse the piece in a strong solution of alum for a few days, or until the steel is sufficiently rusted away to be easily removed with pliers or tweezers. I have tested this scheme and have found that a tap or drill broken off in brass will all turn to rust in time if immersed in alum solution as directed. The alum seems to attack every exposed portion of the steel and eats clear to the center, leaving nothing but rust in the hole. Re-tapping or re-drilling can then be accomplished and the piece saved. In many cases, of course, the tap or drill can be removed after the process has been going on for a short time, but how long depends upon the size of the hole and nature of the break in the tap.

Dayton, Ohio. V. H. MARCELLUS.

RIVETING IN THE TURRET LATHE.

There was occasion to make something like 180,000 pieces like sketch, of No. 12 brass wire about 5½ inches long. The wire came to us cut in lengths so the ends had only to be shouldered in the turret lathe. The heads or washers (shown at *B*) of No. 16 sheet brass were stamped out to shape in a press in the usual way. We then made a holder as shown at *C* which was simply a 1-inch round piece of steel with a slot ¼ inch wide in which were held two rollers together on a 5/16-inch pin, making a concave the shape of rivet head



wanted. This holder was held in the head of lathe; *D* is the end view of *C*. A is the finished end of wire and *B* is end to be riveted. The riveting is done by sticking the heads or washers on the wire, the wire being held in a chuck in the turret; it is then brought up to the rollers with some pressure which spins the end of wire better and faster than it was formerly done with a hammer. After one head is spun on, the wire is caught in another chuck and the process repeated.

Moline, Ill. ALBERT D. KNAUEL.

TO CUT INDIA RUBBER.

Those who have had to cut heavy gaskets have found india rubber an unpleasant material to work. The cut can be made sweet and clean if the knife be kept wet; and if conditions permit, this can be best effected by doing the cutting under water, as good housewives know how to do when peeling onions. Potash water is better than plain.

Hanover, Germany. ROBERT GRIMSHAW.

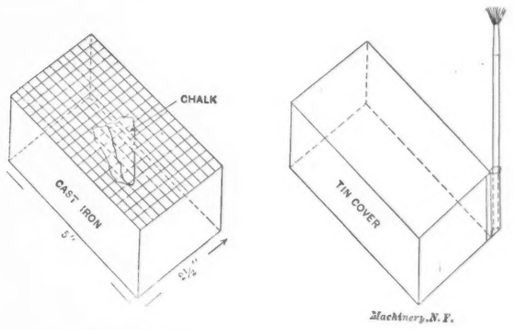
TO MAKE IRON OR STEEL RUST-PROOF.

To make iron or steel pieces rust-proof and at the same time give them a nice finish, heat the article to a dark red and dip it into raw linseed oil; hold it there for a few seconds, then withdraw, let it cool and wipe dry. This treatment will make a permanent and glossy finish. F. PAVLIK, JR.

Winnetka, Ill.

BUILDERS' CHALK EOR SCRAPING AND FITTING.

One thing worth knowing when scraping two surfaces together is that unprepared red builders' chalk is far better and cleaner to handle than the red and blue paints commonly used. Rub the chalk on a cast-iron block grooved lengthwise and crosswise with a pointed tool so the grooves are about 1-32 inch deep and ¼ inch apart. Put on a few drops of machine oil, thus forming a red paint. Considerable rubbing is necessary to bring out the bright red color. This paint



does not have the sticky, gummy nature of the usual red or blue paint. The sketch shows my rubbing block and its tin cover. This cover has a brush holder soldered to one corner so that the brush need never be laid upon the bench to collect dust and dirt. A. L. MONRAD.

New Haven, Conn.

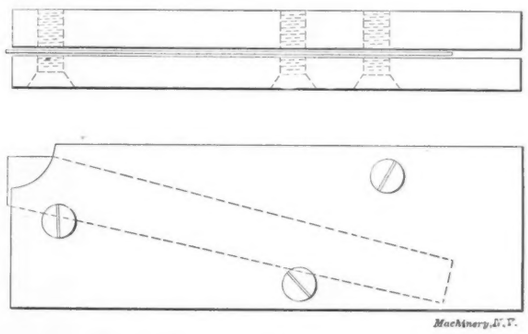
TO PREPARE A SHAFT FOR BABBITTING.

In answer to one of Mr. H. E. Wood's "Don'ts" in the January issue of MACHINERY in regard to wrapping a piece of paper around a shaft when casting babbitt bearing, I would suggest that the next time he has occasion to cast such a bearing, instead of using paper he use a torch with which to smoke the surface of the shaft to be babbitted. I think he will find this far ahead of the scheme he suggests.

Tallmans, N. Y. V. SMITH.

CUT-OFF TOOL FOR THIN BRASS TUBING.

For cutting off a number of pieces of thin brass tubing I constructed the cut-off tool shown herewith. Two pieces of steel were selected of a size which, when fastened together by the three screws as shown, were about of the width and thickness of the lathe tools used with my machine. An ordinary



worn-out hack saw blade having the teeth ground off was then placed between the pieces and tightly clamped. This construction made an excellent cut-off tool. The blade was so thin that the cut wasted very little stock, besides the cutters cost nothing and were easily procured. MILTON BURGESS.

Cleveland, Ohio.

* * *

In the new power house of the Interborough Rapid Transit Company, New York City, the 26,000 horse power of boilers now installed are soon to be equipped with economizers built by the B. F. Sturtevant Company, Boston, Mass. The twenty-eight economizers will contain 7,840 pipes having an aggregate length of nearly 15 miles. They will increase the heating surface of the plant about 25 per cent and store 265 tons of hot water or 18 per cent of the volumetric capacity of the boilers. It is estimated that the saving due to the utilization of heat in the waste gases will average more than 10 per cent for the whole twenty-four hours, which includes the time that the fires are banked.

SHOP RECEIPTS AND FORMULAS.

This page will be used for the publication of shop receipts which the contributors know from experience to be practicable. Nearly all readers of MACHINERY can add something, and it is desired that they use this page as a medium for exchanging useful formulas, thus putting them on record for the general benefit of the craft. All published receipts are paid for.

161. TO DRILL HARD STEEL.

To drill hardened steel make an old-fashioned flat drill and temper as hard as it will stand. Use camphor and turpentine in place of oil. I have drilled steel in this manner which I could not drill in any other way. G. E. HETZLER.

Dayton, O.

162. ALLOY FOR CALIPER AND GAGE ROD CASTINGS.

A mixture of 30 parts zinc to 70 parts aluminum gives a light and durable alloy for gage rods and caliper legs; the gage rods must be steel tipped for the alloy is soft and wears away too rapidly for gage points.

Howard, R. I. JAMES A. PRATT.

163. WHITING SURFACES FOR LAYING OUT WORK.

For laying out work on structural iron or castings a better way than chalking the surface is to mix whiting with benzine or gasoline to the consistency of paint, and then paint it with a brush; in a few minutes the benzine or gasoline will evaporate, leaving a white surface ready to scribe lines on.

Moline, Ill. ALBERT D. KNAUEL.

164. TO BLUE GUN BARRELS.

To blue gun barrels and other pieces dissolve 2 parts of crystallized chloride of iron; 2 parts solid chloride of antimony; 1 part gallic acid in 4 or 5 parts of water; apply with a small sponge, and let dry in the air. Repeat this two or three times, then wash with water, and dry. Rub with boiled linseed oil to deepen the shade. Repeat this until satisfied with the result. F. L. ENGEL.

New Britain, Conn.

165. BELT DRESSING.

A great many people think they know how to make a good belt dressing. This accounts for the many poor ones in the market. Here is one that will do about all the good that any of them will and none of the harm to the structure of the belt. Melt a pound of beeswax in a gallon of neatsfoot oil by a gentle heat. The most convenient way to secure a good mixture is to melt the beeswax first, then add the oil slowly, stirring it constantly until it is thoroughly mixed.

Neponset, Mass. OSCAR E. PERRIGO.

166. TO MAKE CHANGES AND CORRECTIONS ON BLUEPRINTS.

Some times I find it necessary to make changes and corrections on blueprints; to do this I use a solution of sodium carbonate and water, with a little red ink mixed in. This gives a very pleasing pink color to the changes which at the same time is very noticeable. The amount of sodium carbonate used depends upon the surface of the blueprint paper as some coarse-grain papers will look better if less soda is used and *vice versa*. However, the amount of powdered soda held on a five-cent piece dissolved in a bottle of water (Higgins ink bottle) gives very good results. R. F. KIEFER.

Sharon, Pa.

167. LUBRICATING MIXTURE FOR CUTTING TOOLS.

The proportion of ingredients of a lubricating mixture for cutting tools is 6 gallons of water, 3½ pounds of soft soap, and ½ gallon of clean refuse oil. Heat the water and mix with the soap, preferably in a mechanical mixer; afterwards add the oil. A cast iron circular tank to hold 12 gallons, fitted with a tap at the bottom and having three revolving arms fitted to a vertical shaft driven by bevels and a fast, loose pulley, answers all that is required for a mixer. This should be kept running all through the working day.

Manchester, Eng. H. T. MILLAR.

168. WATERPROOF CEMENTS FOR GLASS.

Probably the simplest and best aquarium cement (the formula for which is recommended by the United States Fish Commission) is made as follows: Stir together by weight 8 parts pulverized putty (dry whiting), 1 part red lead and 1 part litharge. Mix as wanted for use with pure raw linseed oil to a consistency of stiff putty. Allow a week to dry before using.

Another waterproof cement is made by dry mixing 10 parts each by measure of fine dry white sand, plaster of paris and litharge and 1 part powdered resin. Mix as required to a stiff putty with boiled linseed oil. The linseed oil must be free from any trace of adulteration with fish oil. It is sometimes necessary to boil pure raw linseed oil a few moments to drive off the water. A. L. GRAFFAM.

Indiana, Pa.

169. TO TEMPER SMALL COIL SPRINGS.

To temper small coil springs in a furnace burning wood the springs are exposed to the heat of the flame and are quenched in a composition of the following preparation: To a barrel of fish-oil 10 quarts of rosin and 12 quarts of tallow are added. If the springs tempered in this mixture break more tallow is added, but if the break indicates brittleness of the steel rather than excessive hardness, a ball of yellow beeswax about 6 inches in diameter is added. The springs are drawn to a reddish purple by being placed on a frame having horizontally radiating arms like a star which is mounted on the end of a vertical rod. The springs are laid on the star and are lowered into a pot of melted lead, being held there for such time as is required to draw to the desired color. A. L. MONRAD.

New Haven, Conn.

170. TO HARDEN STEEL WITHOUT SCALING.

Articles made of tool steel and polished may be hardened without raising a scale, thereby destroying the polish, by the following method: Prepare equal parts in bulk of common salt and (fine) corn meal, well mixed. Dip the article to be hardened first into water, then into the mixture and place it carefully into the fire. When hot enough to melt the mixture, take from the fire and dip or roll in the salt and meal, replace in the fire and bring to the required heat for hardening. Watch the piece closely and if any part of it shows signs of getting "dry" sprinkle some of the mixture on it. The mixture, when exposed to heat, forms a flux over the surface of the steel which excludes the air and prevents oxidation, and when cooled in water or oil comes off easily, leaving the surface as smooth as before heating. Borax would possibly give the same result, but is sometimes difficult to remove when cold.

Rock Falls, Ill. E. C. NOBLE.

171. CEMENT FOR LEATHER BELTS.

In an ordinary glue-pot soak over night a pound of good fish glue in a pint of cold water. Heat this up, stirring until completely dissolved. Then add one ounce of dry white lead. When the mixture has been again thoroughly stirred and is nearly cool, add one ounce of grain alcohol, and stir it well in. Heat up the cement again when it is wanted for use. In the use of this cement care should be taken to have the laps freshly and smoothly cut, and as clean as possible. The cement should be evenly spread with a brush over both surfaces and the surfaces placed in contact as quickly as possible, and on each side of the lapped belt should be placed a previously warmed board and the whole clamped together for an hour or two according to the width of the belt, its thickness and the amount of strain it will have to stand. This cement can be made in larger quantities by observing the same proportions, and when cool it may be cut up into small pieces and kept in good condition in a fruit jar tightly closed. When it is wanted it will not be necessary to heat up more than is wanted for the job in hand. OSCAR E. PERRIGO.

Neponset, Mass.

* * *

Grease is a valuable lubricant where machinery is running in a dusty atmosphere, because of its sealing quality when used in a compression grease cup. Fed into a bearing it forces out along the shaft and effectually prevents the intrusion of grit. Unfortunately its coefficient of friction is high and where efficiency of transmission is important the use of grease is not an attractive proposition. Locomotive tests made in the Pennsylvania Railroad System's testing plant at the St. Louis Purchase Exposition showed that the use of grease on the driving axles increased the friction from 75 to 100 per cent.

HOW AND WHY.

A DEPARTMENT INTENDED TO CONTAIN CORRECT ANSWERS TO PRACTICAL QUESTIONS OF GENERAL INTEREST.

Give all details and name and address. The latter are for our own convenience and will not be published.

15. E. M. P.: I should like disinterested advice from your readers as to the best type of power hammer for the blacksmith shop of a bridge shop where but one hammer is required and the work includes forging of small tools as well as general work running up to bars as large as 6 x 5 inches.

We ask for suggestions from our readers.

16. J. S. P.—The accompanying cut shows three tangent circles, E, E_1 and E_2 drawn within and tangent to the bounding circle $A\,B\,D$. Give a general formula for solving R when r is known.

A. Draw the radius $B\,C$ through the center of one of the smaller circles, say E, and the radius $A\,C$ tangent to it. Draw the radius $c\,f$ perpendicular to $A\,C$. Then

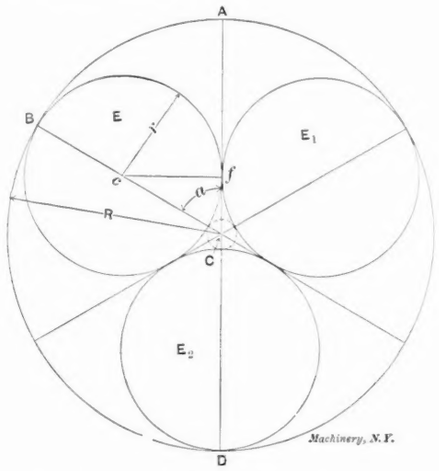
$$R = r + \frac{r}{\sin a}, \text{ or } R = r + r \operatorname{cosec} a$$

in which

R = radius of bounding circle.

r = radius of tangent circles.

a = angle subtended at center, or $360 \div 2n$, n being the number of tangent circles.



With three tangent circles as shown angle $a = 60$ degrees, and if, for example, $r = 0.232$ it follows that

$$R = 0.232 + \frac{0.232}{0.866} = 0.5$$

and the ratio of R to r is as 1 is to 0.464. The following table gives the ratio of maximum tangent circles from 3 to 16 inclusive, the radius R of the bounding circle being 1:

No. of Circles.	$2r$	No. of Circles.	$2r$
3	0.464	10	0.236
4	0.414	11	0.219
5	0.370	12	0.206
6	0.333	13	0.193
7	0.302	14	0.182
8	0.276	15	0.172
9	0.255	16	0.163

The radius of the inner circle, denoted by the dotted line, will be the difference between R and $2r$, of course, or 0.036 in the above example.

17.—I. H. C.—Can any of your readers inform me how to drill chilled cast iron giving full details of the process?

A—Referred to H. J. Bachmann, who replies: "I witnessed some years ago the drilling of a lot of small iron castings for toy work that had become accidentally chilled at the spot where the hole was to be drilled. The drills were hardened at the first trial by inserting them while red hot in a stick of sealing wax, which made them quite hard, but not hard enough to drill completely through the casting before becoming dull. All the various known lubricants were tried, but they all seemed to have the effect of glazing the work and thus retarding the drilling. As a last resort the drills were hardened as described in the recent issue of MACHINERY for drilling hardened steel, and instead of using liquid lubricant a strong blast of compressed air was used to keep the point of the drill cool, because of the well-known fact that the edge of any cutting tool made of carbon steel will last longer when the heat is conducted away from the cutting point." The receipt mentioned by Mr. Bachmann for drilling hardened steel was contributed by him to the February number of MACHINERY. The directions were to harden in sulphuric acid, the pure acid being placed in a dish to the depth of about ⅛ inch and the drill being heated and dipped into the acid to that depth, making the point extremely hard while the remainder remains soft.

A KINK IN DIVISION.

Robert Grimshaw writes: By the machinist and apprentice no arithmetical operation is more frequently encountered than the division of inches and fractions thereof by two, as in laying off center lines, spacing, etc. While the division of an even number and a fraction by two is easy enough to almost any one, it is surprising to note how much "fussing" is done by many over the division of an odd number and a fraction.

The following method is very convenient:

To divide an odd number and a fraction by two write the expression in the ordinary manner, draw a line beneath it and add together the numerator and denominator of the fraction, placing the sum in position for the numerator of the fraction of the quotient. For the denominator of this fraction multiply by two the denominator of the fraction which is being divided. Deduct one from the whole number of the expression that is being divided, and divide the remainder by two. The following examples will show clearly how the method is operated:

$$\frac{31\frac{31}{32}}{15\frac{63}{64}}; \quad \frac{1\frac{1}{32}}{\frac{33}{64}}; \quad \frac{7\frac{19}{33}}{3\frac{52}{66}}; \quad \frac{19\frac{57}{141}}{9\frac{198}{282}}$$

* * *

The efficient working of a machine tool depends upon how rigidly the work and cutters are supported, and another factor that is important is weight. No matter if the frame of the machine is very rigid, if it lacks weight, there is likely to be more or less vibration when the cut is of intermittent nature. The adding of iron to secure mere weight without adding materially to the strength requirement is costly and undesirable, although in a measure it must be done in the making of most machine tools. An alternative and usual plan is to make up for want of weight by a heavy foundation, but in some classes of tools the foundation is too far removed from the zone of cutting action to materially help in preventing vibration. The growing use of concrete for almost all constructive purposes has suggested that the waste interior space in many machine frames could be profitably employed by filling it full of an approved concrete mixture which would have the merit of cheapness and would give the machine the weight and solidity that is so beneficial in getting a smooth cutting action. In the case of a heavy engine lathe, for example, which has a bed extending to the floor, the whole interior space of the bed could be filled up with concrete, thus adding many hundred pounds to the weight of the machine and at the same time stopping the nuisance of having the space employed as a "catch-all" for chips, waste, clamps and blocking of all kinds.

* * *

Mr. E. E. Wood has recently accepted the position of general manager for Geo. D. Walcott & Son, of Jackson, Mich., builders of machine tools. Mr. Wood was formerly general superintendent of the Jones & Lamson Co., Springfield, Vt., and was later connected as a special sales agent with the Niles-Bement-Pond Co. and the Pratt & Whitney Co., which connections he severed to accept his new position.

* * *

The shop receipt No. 147 "Alloys for Drawing Colors on Steel" which appeared in the February issue was erroneously credited to Max Dehne; the contributor was Max J. Oches.

MACHINERY AND TOOLS.

A MONTHLY RECORD OF NEW APPLIANCES FOR THE SHOP.

HENDEY-NORTON LATHES.

Two new products of the Hendey Machine Co., Torrington, Conn., are shown in the accompanying illustrations. The first is an all-geared head stock lathe, Figs. 1 and 2, and the second is a modification of their belt-driven standard type lathe, which is now fitted with a tie-bar reinforcement of the lathe head, Fig. 3. Both of these designs have been developed for the purpose of securing stiffness and power for high-speed steel work and the desired results have been accomplished without making the lathes more cumbersome or clumsy to operate, which cannot be said, by the way, for some of the efforts that have been put forth to meet the new high-speed steel conditions.

The head-stock of the geared drive lathe is compactly built with no overhang outside of the limits of the gear box and the back gears of the ordinary lathe. It is of the same length as the regular pattern head and the construction of the main spindle and bearings is identical in both types. Power is transmitted to the drive through the single driving pulley *A*, Fig. 2, and is transmitted to any one of the nest of four gears which turn together as a unit and run loose in the main spindle unless locked with it by the clutch. The sliding rocker, *C*, on shaft *B* carries transfer gears (not shown) which may be brought into mesh with the desired cone gear by the movement of a handle projecting through the slot *K* at the front of the head stock. This handle controls the position of the rocker in a manner similar to the well-known arrangement in the Hendey-Norton feed box. There are eight mechanical changes of speed for the spindle, four direct and four running through the back gears. The back gears are permanently in mesh with their mating gears, which revolve freely on the spindle. The change from direct to back geared drive is made by the clutch working between the large gear of the cone and face gear, the clutch being operated by the lever at the front end of the head stock.

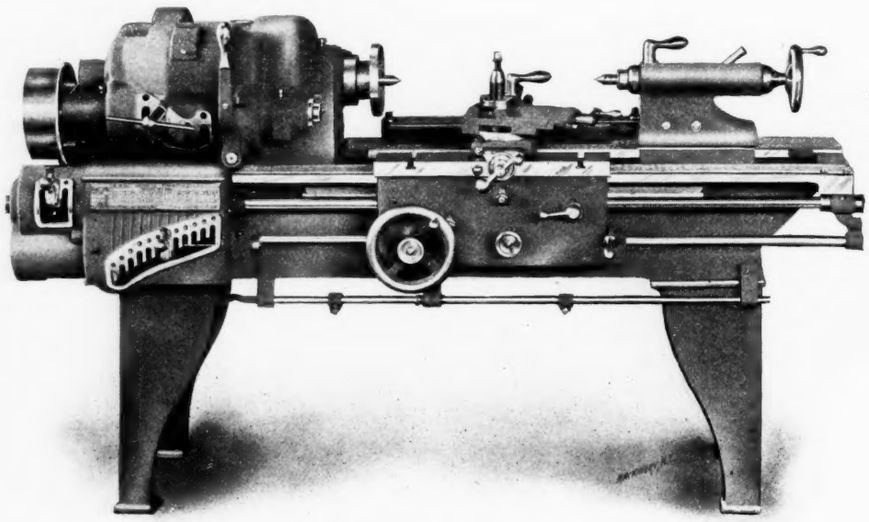


Fig. 1. Hendey-Norton Lathe with Geared Head.

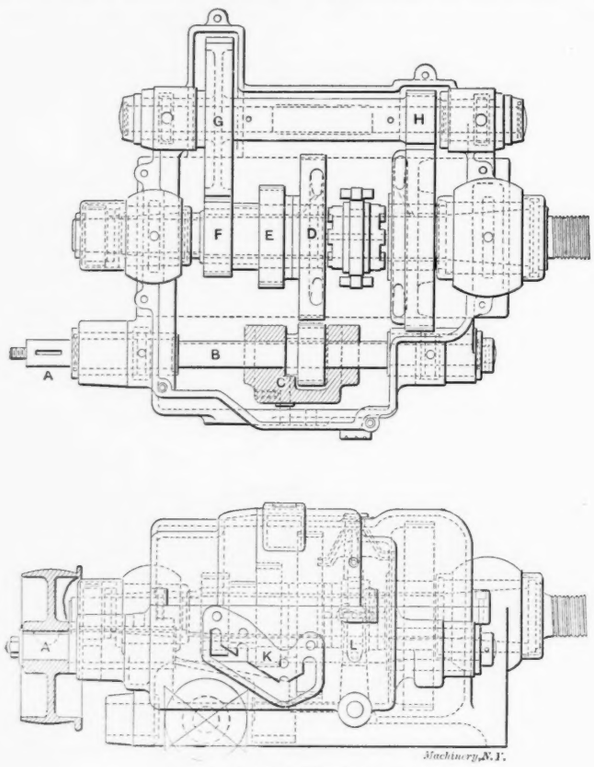


Fig. 2. Details of Geared Head.

A feature of the head-stock of this lathe is the arrangement for oiling all of the bearings while the lathe is running. In the case of the main bearings of the spindle, and of the back gear and pulley shafts, this, of course, is easily accomplished, since the several bearings are easily accessible from the outside of the casing for oiling, and in addition are equipped with the usual ring oilers with which the Hendey Machine Co. fit the main bearings of their lathes. The face gear and the cone gears on the main spindle, however, both of which run loosely on the spindle at times and are enclosed by the casing, are not so accessible and special provision had to be made for oiling. As apparent in Fig. 2, annular grooves are cored in the face of the large cone gear and of the face gear. These grooves are so shaped as to retain oil, both when the gears are stationary and when running, and by suitable oil channels this oil is carried to the shaft. By raising a small cover on top of the casing oil can be easily supplied from an oil can to either of these annular grooves regardless of whether the gears are at rest or in motion.

A positive clutch instead of a friction clutch is used and all the gearing is of steel except the large face gear and the large back gear. Changes of speed and the throwing in or out of the clutch can safely be accomplished without stopping the driving shaft, except to slow down for the highest speed changes. The heavy construction of this head coupled with the steel gearing makes the lathe effective for all conditions of work with high speed steel and numerous tests made at the factory show the power to be ample for any requirement.

The tie-bar, which is now used on the head stocks of the standard type of Hendey-Norton lathe, is for the purpose of stiffening the front bearing, making it capable of supporting the spindle under heavy duty conditions with absolute rigidity. Although the front bearing and its support have been made unusually heavy in the standard lathe, it was found that it could be sprung an appreciable amount under heavy cuts with high-speed steel, especially in chucking work. Under such conditions there is also a tendency for the spindle to be driven into the conical seat of its bearing with a great deal of pressure which, coupled with the slight deflection of the bearing due to the end thrust, tends to bind the spindle and cause it to run hard. This is overcome by the use of the tie-bar. Although in appearance the tie-bar looks strange to a

mechanic at first, it seems to be the verdict of those who have become accustomed to it that the lathe really looks bare and incomplete without it. At least the writer can testify that after having spent an hour at the factory of the Hendey Machine Co. where this new type of lathe was largely in evidence, the old style looked about as strange to him as the new style

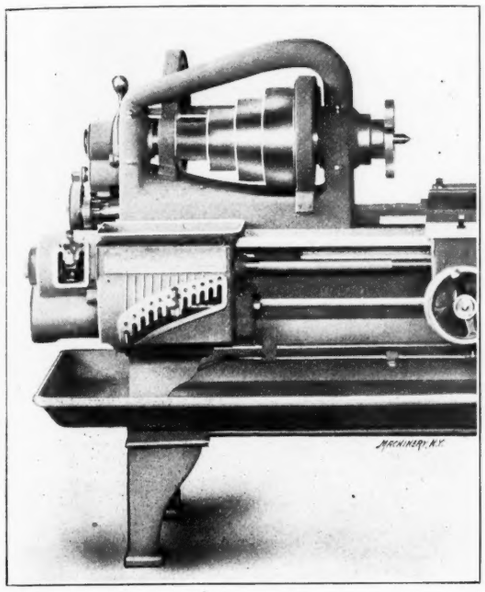


Fig. 3. Tie-bar Headstock used on Hendey-Norton Lathes.

did when he first saw it. It in reality seems to be as useful an adjunct to the lathe head, and perhaps even more necessary, than the tie-bar used for the head of a milling machine; for although the thrust is heavy in end milling and in boring on a milling machine, it is scarcely greater than is met with in work that now is accomplished in the engine lathe.

THE "EXACTO" PACKING GAGE AND CUTTER.

The purpose of this device, shown in Fig. 1, is to facilitate cutting off square or round packing to exact length with the ends beveled in the proper manner, as shown in Fig. 2, the claim being that a stuffing box packed in this way will give better satisfaction than with ring packing, allowing at the same time a greater range of choice as to materials. As all the rings cut in this apparatus are of exactly the same size, there is no possibility of waste from errors in cutting, no loss of time in fitting the packing to the rod, and, as the packing is right, a tight joint and a workmanlike job is assured.

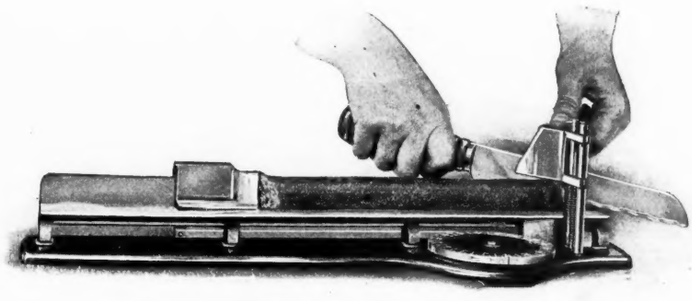


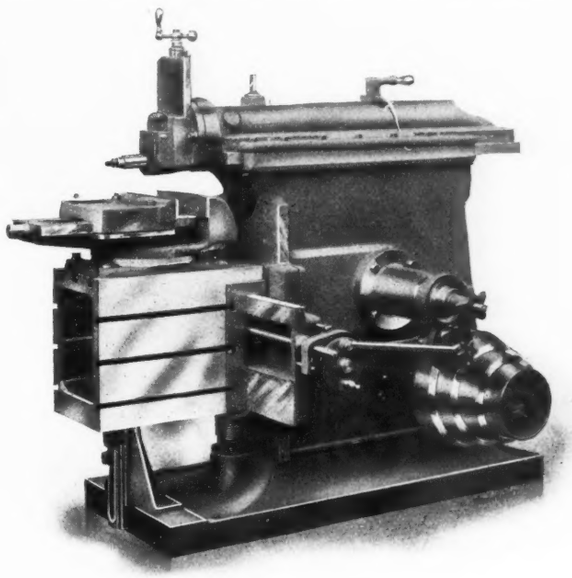
Fig. 1. "Exacto" Packing Gage and Cutter in use.

Fig. 2. Form of Packing Ring Produced.

The method of operation will be readily understood. The graduated dial shown is set to agree with the diameter of the rod plus the diameter of the packing. For instance, if the rod is 2 inches in diameter, and the packing 1 inch, add them together and set the dial at 3 inches. This locates the bevel gage at such a position that the packing is of the right length to just fill the required space. The packing is now inserted in the trough of the device with its beveled end resting in the gage; after the gage is set the proper length it may be secured by a setscrew to preserve the setting for as many rings as it may be desired to cut. After inserting the packing it is held in place by placing the thumb of the left hand upon the knife guide, and is cut with a knife having a serrated edge. The knife is furnished with the outfit. The device is sold by Green, Tweed & Co., 17 Murray St., New York.

TWENTY-EIGHT INCH BACK-GEARED CRANK SHAPER.

The accompanying half-tone shows a shaper which has been designed by the American Tool Works Co. of Cincinnati, Ohio. It is one of a new line, built by this concern to meet the changed conditions which the shaper, which was formerly regarded as a tool-room machine, now has to meet. It is built to stand severe requirements in heavy manufacturing and is of sufficient strength and rigidity to use high speed steels to their best advantage. The column is strongly braced internally and is reinforced outside on the line of strain by a wide deep rib cast integral with the wall. The ram bearing pro-



Twenty-eight inch Back-geared Crank Shaper.

jects out at both the front and the rear. The base is of the extension type with a pad at the end to receive the table support, and is provided with raised rim to hold oil drippings, thus protecting the floor. The ram is designed for uniform rigidity throughout the entire length of stroke, is thoroughly braced by internal ribs and has long wide bearings with a tapered gib for taking up the wear. The stroke of the ram is positive and has 8 rates of speed, ranging from 15 feet to 181½ feet per minute with full stroke. The length of the stroke may be changed at will without stopping the machine. The device for positioning the stroke is located near the head and may be operated while the machine is running. The machine is readily changed from single to back geared drive by operating a convenient lever and it has the unusual back gear ratio of 1 to 29.4, giving it great power for taking heavy cuts. The slide on the head is fitted with a tapered gib, has a large

tool post for using holders with inserted cutters, and a tool-steel tool-post screw and serrated back plate.

The table is a box form with T-slots on back and sides, planed from the solid metal, is braced internally, and is fitted to the apron by a method which ensures accuracy and stiffness and at the same time allows it to be readily detached. The apron is accurately fitted to the cross rail and is provided with taper gib for taking up the wear; when the table is removed, work may be clamped to the face of the apron, three T-slots being provided for this purpose. The cross rail is of box form, heavy and strongly ribbed, and is secured to the column ways by clamps and plates in such a way to prevent it from dropping when the binder bolts are loose. The crossrail is provided with a telescopic elevating screw of large diameter provided with ball bearings.

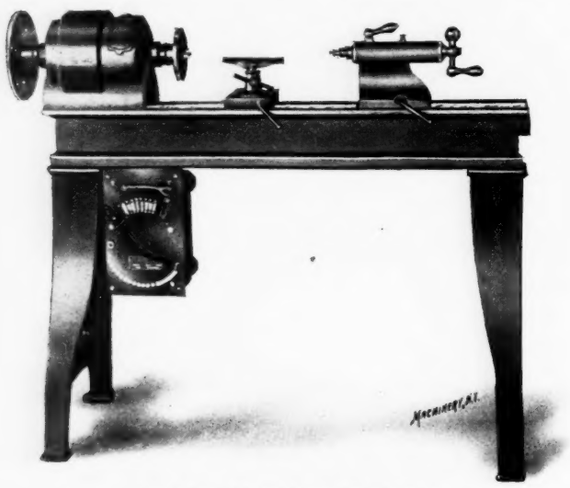
The cross feed has a range of from 0.0114 inch to 0.250 inch with quick adjustment for any desired feed. It adjusts itself to any elevation of the rail. The reversing of the feed is accomplished by turning the knob shown in the cut without stopping the machine. The vise covers nearly the entire area of the table top and has wide deep jaws faced with steel. The table support is clamped to the base and has an adjustable slide carrying a roller at the top which rests on a planed way at the bottom of the table, a design which protects the roller from riding over accumulated chips or dirt. This table support is not a part of the regular equipment, but is furnished at extra cost.

The driving shaft journals are bushed with bronze. All shafts are of high carbon crucible steel accurately ground and the points of danger are amply covered to prevent injury to the operator. The regular equipment includes vise, countershaft, and all necessary wrenches. When specified and at extra cost, the makers are prepared to furnish power down-feed to the head, a circular attachment, mold makers vise, tilting table, four speed gear box, and an improved motor drive.

The length of the stroke of this shaper is 28½ inches, the down feed of the head is 9 inches, the vertical travel of the table 13¼ inches, horizontal travel of the table 31 inches.

MOTOR-DRIVEN SPEED LATHE.

The accompanying half-tone shows a motor driven speed lathe of pleasing design. The motor is mounted directly on the bed of the lathe taking the place of the belt driven head stock generally used, and has the spindle of the machine for its armature shaft. The rheostat is mounted under the head



Fay & Scott Motor-driven Speed Lathe.

stock in a convenient location. The fields of the motor are made in accordance with a patented design which gives a large ratio of spindle speeds without sacrificing the efficiency of the mechanism. The spindle is journaled in taper bearings of bronze with convenient adjustment for taking up wear and end thrust. The size shown swings 10 inches over the bed and 5½ inches over the rest holder, and has a rheostat which gives 12 motor speeds ranging from 800 to 3,000 revolutions per minute with a ½ horse power motor connected to a 110 volt direct current. The spindle has provision for a face plate at the rear for large diameter turning and has a 9/16 hole throughout its length. The beds are made in lengths of 4, 6 and 8 feet with a net weight of 459 pounds for the four-foot size. With each lathe is furnished one pair of spur centers, one rosette or screw center, three rests of different lengths for turning, and two face plates. This machine is made by Fay & Scott, Dexter, Maine.

ADJUSTABLE ROUGHING AND FINISHING REAMERS.

R. M. Clough, of Tolland, Conn., makes the adjustable roughing and finishing reamers illustrated below. Fig. 1 shows the roughing tool. It is made with four blades of small enough diameter to allow a slight amount for a finishing chip, and with cutting surfaces at the ends of the blades as well as on the outside edge. The finishing reamer, Fig. 2, has six blades unevenly spaced with the bottom of the slot on an incline. The rear ends of the blades are dove-tailed to an adjustable

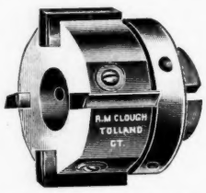


Fig. 1. Roughing Reamer.

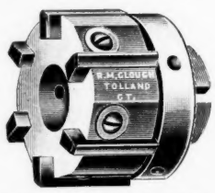


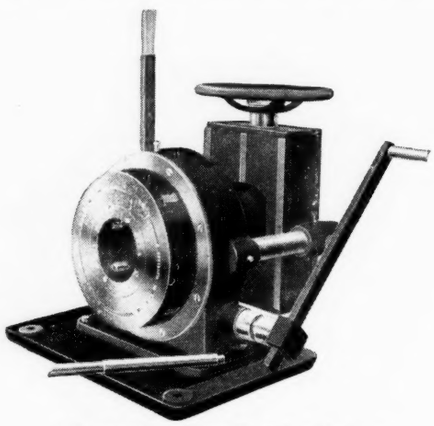
Fig. 2. Finishing Reamer.

threaded bushing which serves to move them in or out together in the inclined slots, and thus varies their diameter. The total variation obtainable for a given reamer is ¼ inch. The design of the adjusting mechanism is such as that the blades are drawn very firmly to the bottom of the slot.

This reamer is known as "style D," and is designed particularly for reaming motor cycle and automobile cylinders. They are made in sizes from 2 to 6 inches in diameter.

THE LOEW VICTOR PIPE MACHINE.

The pipe threading machine shown in the accompanying half-tone is built by the Loew Mfg. Co., Cleveland, Ohio, in three sizes, covering a range of from ¼-inch to 6-inch pipe. It is solidly constructed and designed to resist rough usage, yet is so light as to be conveniently portable, weighing less than other machines of its kind and requiring considerably



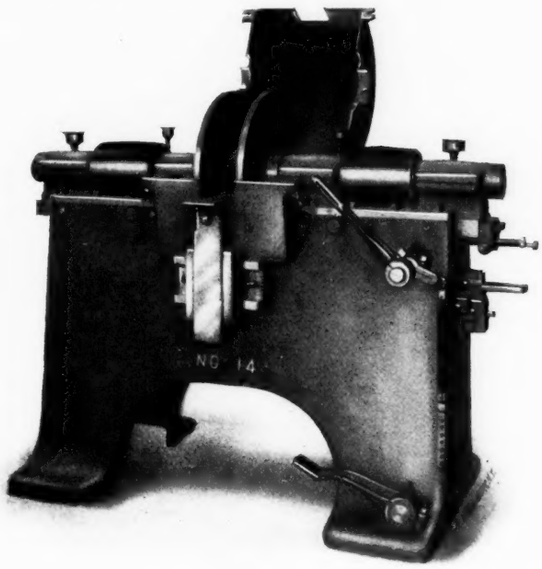
A Compact Hand Pipe Threading Machine.

less space. It comprises a two-jawed vise operated by a hand wheel and longitudinally movable by operating the lever shown at the back of the machine, together with a revolving die head. The die head is rotated through a double thread worm gear instead of by bevel gears, as is the usual practice. The two larger sizes are equipped with outside gear wheels encased in a guard, giving the machine two speeds, either to be used as desired, depending on the size of the pipe being cut. The dies, which are in four pieces, are of high grade die steel and are so shaped that they can be reground by the user, thus making it unnecessary to return them to the factory when they are dull. The grinding does not change the shape of the cutting face of the dies. The head is self locking and is so designed that during the operation of cutting the thread

tne pressure of the pipe against the die prevents all danger of disturbing the adjustment. No levers or locking devices are required and there are no projections on the faceplate. In operation it is unnecessary to reverse the machine and back the pipe out of the dies. When the end of the cut is reached the hand bar shown is inserted in a hole in the edge ot the face plate, when the continued operation of the crank opens the dies, at the same time cleaning off the burrs from the tnread.

DOUBLE HEAD DISK GRINDER.

This grinder, shown in the accompanying half-tone, is designed to finish two opposite faces of the work presented to it at the same time. For this purpose the work is mounted on an adjustable table between two disk wheels which are independently driven and have suitable means for moving them toward or away from each other. The lever shown at the right actuates a pinion which meshes with two racks, one above it, the other below, which in turn are connected to the right and left hand heads respectively. Thus a downward pressure on the lever or the pedal which is connected with it brings the two grinding disks toward each other for performing the desired operation on the work. Both heads can be clamped in any position. The lower rack can be dropped out of mesh and the left hand head locked, thus allowing only the right hand head to be moved to the work.



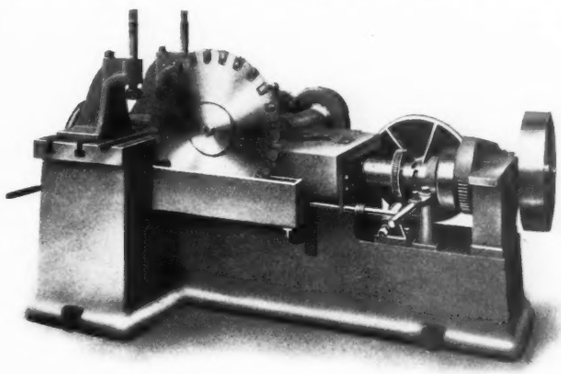
Double Head Disk Grinder.

The reason for making both heads movable by the lever is that it is sometimes necessary to grind off more from one side of a piece of work than from the other, or the two opposite sides may not be of equal area, in which case the grinding will not be done at all evenly. Under either of these conditions the work is secured in a holder and the center rest is so adjusted that the right amount can be ground off on each side. The wheels are brought back by the spring shown, which is attached to an adjustable lever, thus permitting the operator to use the foot pedal and devote both hands to handling the work. There is a back stop to prevent the wheels from moving back too far and a screw stop which regulates the forward movement of the head. The foot lever is connected to the rack gear shaft by sprockets and a chain, the latter being adjustable to take up back lash.

The wheels are covered with a cast iron hood, the top half of which is hinged at the back and locked at the front with hinged bolts and thumb nuts. The opening in the front for inserting the work is 8 inches by 12 inches. Adjustable sheet metal shields are used which are attached to the hood with thumb screws. With these the opening can be reduced to any size desired. At the back of the machine is a flanged opening from the bottom of the gap in the bed for connecting the exhaust pipe. The machine weighs about 3,500 pounds and has practically the same dimensions as regards driving power, spindles, wheels, etc., as the No. 4 grinder, built by the same makers. The wheels are 20 inches in diameter by ¾ inch thick. The greatest distance between the wheels is 14 inches, the least distance zero. The Gardner Machine Tool Co., Beloit, Wis., are the builders.

NEWTON COLD SAW CUTTING-OFF MACHINE.

The accompanying half-tone shows a No. 3 bar cold saw cutting off machine fitted with a 26-inch Taylor-Newbold inserted tooth saw blade. The machine is the product of the Newton Machine Tool Co., Philadelphia, Pa., and has a capacity for round stock up to 8 inches in diameter and for square stock up to 7 inches. The saw is driven through spur gearing by a worm and worm wheel of steep pitch running in a bath of oil. The driving gearing has a ratio of 22 to 1 with



Newton 26-inch Cold Saw Machine.

a belt capacity of 6,000 square feet per minute, being specially designed to give the power required to operate the saw to its fullest capacity. The saw carriage has a variable automatic feed through disks with power quick return for withdrawing the saw blade from the cut. Automatic stops are provided in both directions and a special table will be furnished if desired for cutting off T-rails. In the shops of the manufacturer the machine has cut off forgings of 45. carbon stock 6 inches in diameter in 4½ minutes.

FOOT POWER CORE CONING MACHINE.

The foot power core coning machine shown in the accompanying cut has been designed to fill the demand for a machine to finish the ends of stock cores as made on modern core machines in core rooms with no power available. The gage is so arranged as to give a standard taper of 3/16 to the inch on the side or ⅜ to the inch difference in diameter, and with the gage any length of core can be used to suit the required conditions. Various standards have been proposed at different times for core prints different from the standard proposed by the manufacturers of this machine, but after considerable experimenting the makers adopted this in their own factory and have sold quite a number of machines adjusted to this standard, to the entire satisfaction of the users.

Fig. 1. Cores with Coned Ends.

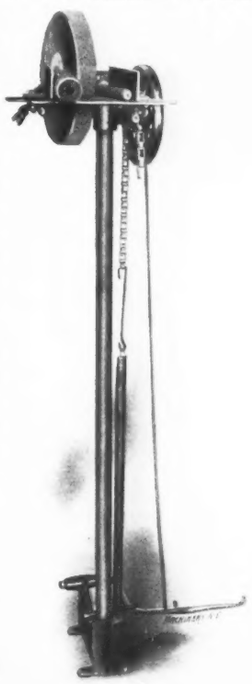


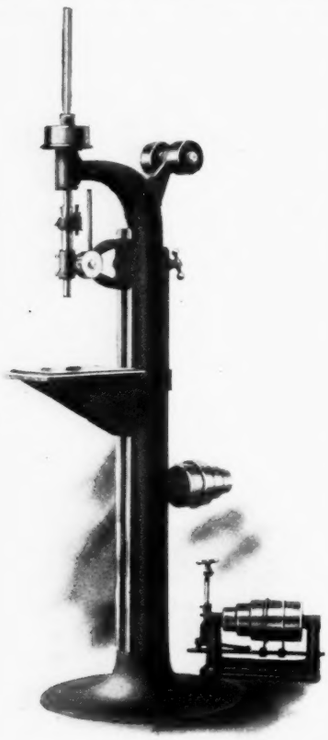
Fig. 2. Core Coning Machine.

The fact that the emery wheel is revolved by foot power allows both hands to be used in turning the core around and holding it against the gages, a thing difficult to do with one hand only. The gages are quickly changed, and on the machine illustrated give a capacity of from ⅜ inch to 3¼ inch diameter. Each side of the emery wheel is used for the cone while the front may be used as an emery grinder. The wheel used is 8 inches in diameter by 1¼ inches face.

Fig. 1 shows some samples of the work done by the machine. The Falls Rivet and Machine Co., Cuyahoga Falls, Ohio, are the builders.

FOX SINGLE SPINDLE SENSITIVE DRILL.

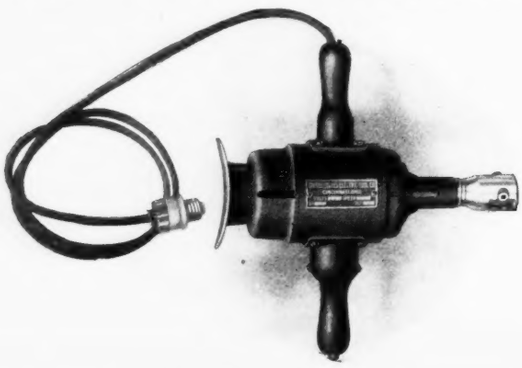
Among the features of this new drill is the fact that the frame is composed of a very strong one-piece casting with a base 24 inches in diameter. The table has 26½ inch vertical adjustment. The spindle is counterbalanced by a quick acting spring and the spindle bracket is clamped by a straight pull from the back instead of from the side, as in former designs, hence there is no tendency to spring the spindle out of line. Long bushings are used in the upper cone bearings. An adjustable collar in the spindle sleeves provides an accurate depth gage. The table has an oil groove around its edge and is conveniently locked in position by an eccentric clamping lever which gives a quick and positive action. The countershaft carries a three-step cone pulley and tight and loose pulleys arranged on novel lines, the tight pulley and the cone pulley being in one piece and revolving loosely upon a fixed shaft in the same manner the loose pulley does. This machine is built by the Fox Machine Co., 815-825 North Front Street, Grand Rapids, Mich.



Fox Single Spindle Sensitive Drill.

SINGLE SPEED ELECTRIC DRILL.

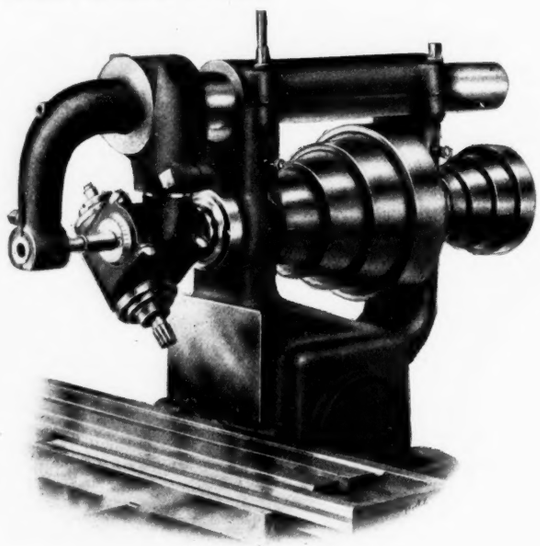
Besides the line of variable speed drills made by the United States Electric Tool Co. of Cincinnati, Ohio, they have recently put on the market a complete line of single speed drills of which an example is shown in the accompanying cut. These tools are comparatively light in weight and much smaller for a given size, and are powerful and efficient as well. The tool is easy to operate, being provided with two handles opposite each other in one of which the current enters, while the other is provided with a push-button switch. The tool will be furnished either with a wooden spade handle or with a nickel alloy breast plate so arranged that it may be set at any angle the operator may choose. The armature shaft is provided with a fan which constantly draws a current of air through the perforated end plate, circulating it through the inside of the motor and exhausting from the front end thus cooling both the armature and drill. This feature is provided with all the drills made by this firm, both of the single and variable speed type.



Single Speed Electric Breast Drill.

VERTICAL ATTACHMENT FOR THE FOX MILLING MACHINE.

Fig. 1 shows a new vertical attachment recently designed by the Fox Machine Co., 815-825 North Front St., Grand Rapids, Mich. One of its novel features is the fact that it provides for adjustment transversely, that is, in line with the main spindle. It will swivel through an arc of 90 degrees from vertical to horizontal, and by reversing it upon the spindle and overhanging arm it will swing between the vertical and horizontal positions on the outer side, thus giving a full range of 180 degrees. A graduated dial shows the angle at which the spindle is set. The spindle is extra heavy and is provided with a draw-in bolt for collets and mills; it has a No. 7 Brown & Sharpe taper hole. Its bearings are provided with convenient means for taking up wear.



Fox Vertical Milling Attachment.

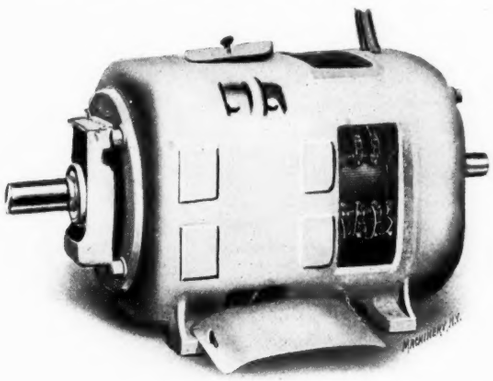
The No. 3½ milling machine on which vertical attachment is shown mounted has been recently improved in a number of particulars. A change has been made in the feed mechanism by which the hand rack feed is placed at the left; a ratchet lever is substituted for the ordinary type heretofore used. The spindle design has also been improved.

WESTERN ELECTRIC HOISTING MOTORS.

The Western Electric Co., Chicago, Ill., in accordance with their policy of specializing their motors to suit any service for which there is a considerable demand, have recently developed the type "H" crane motor line, of which an example is shown herewith. The crane motor is required to work under unusually discouraging conditions. It is placed in restricted space, must be of low speed to reduce the gear ratio to a minimum, and must be able to withstand great overloads and sustain severe shocks. A type of brake capable of stopping the motor almost instantly is often used, producing a very heavy strain in armature shaft. The service is often such as to render it necessary to enclose the motor, thus requiring that it be designed with a wide margin of safety. These various conditions require careful mechanical and electrical design, together with the use of the best materials obtainable for the purpose desired.

The governing factor in the operation of a crane motor is

the torque required by the load. The torque of an electric motor is directly proportional to the magnetic flux and the current flowing through the armature. In a series wound motor the flux is increased in almost direct proportion to the current up to the point of magnetic saturation, and the torque thus developed is proportional to the square of the current. Beyond the saturation point the torque does not increase so rapidly; the speed at the same time decreases with the increasing load—a valuable characteristic of this type, as it does not make the speed of the motor dependent on the judgment of a perhaps ignorant operator. These advantages of the series wound motor have been accentuated in the "H" design to which this description refers. The magnetic circuit is of large area, and its low density under normal conditions permits a great increase in flux for a heavy load before the saturation point is reached. The armature has little reactance upon the field, permitting the machine to run under wide changes of load without sparking.



Western Electric Hoisting Motor.

The losses by heat in a hoisting motor have to be reckoned with somewhat differently than for other motors for constant service. When a heavy load is being lifted great quantities of heat are liberated, a large part of which must be radiated during the operations of stoppage and lowering of the load, when no heat whatever is generated. If it were possible to operate the motor continuously for the load which it is called upon to carry intermittently, the temperature would soon reach a dangerous degree of heat. Study along these lines is necessary before a suitable motor can be selected for any given service. In rating these motors, therefore, the time of operation is of equal importance with the load, and for this reason they are not rated on the basis of output alone. From the nature of the design these machines are somewhat costlier than those of similar sizes in the constant-speed class, but as the electrical portion of any hoisting equipment is usually a small part of the total cost, this slight increase, which adds greatly to the general efficiency, will be well repaid.

SELF-DEMAGNETIZING ELECTRO-MAGNETIC CLUTCH.

This clutch, built by the Pick Electric Co., 4 and 6 Warburton Ave., Yonkers, N. Y., has as a special feature the fact that trouble due to residual magnetism has been eliminated. When applied to a planer in the manner shown in Fig. 2, with the table running light, on cutting off the current from the clutch, the friction surfaces at once separate, allowing the driving gears to stop. This is accomplished even though the design is such that the magnet face and the armature are in direct contact with each other when the coils are excited, and is an evidence that there is little tendency for the coil to attract the armature when the circuit is broken.

The arrangement shown in Fig. 1 has been especially designed for such service as planer driving. Power is applied to shaft *A* on which are mounted a spur gear and a sprocket which drive respectively gears *D* and *E*, which are loose on shaft *B*. Keyed to shaft *B*, from which the planer is driven, is the member *C*, either side of which may be energized by a weak current from the controlling switch. If the right hand side be energized, *C* and *E* will be drawn together with sufficient force to drive shaft *B* from shaft *A* through the Morse chain and sprocket, as shown, giving a comparatively low rate of speed for the cutting movement of the table. When the table reaches the end of the cut the dog, instead of throwing a shipper as usual, trips a switch, transferring the energizing current from the right to the left hand side of member *C*, thus bringing *C* and the armature *D* into contact. Armature *D* is driven by the gearing in an opposite direction and at a faster rate of speed than *E*, and the table is thus returned ready for another cut. The tripping of the switch at the rear end of the stroke again starts the table forward. As seen in actual operation, the clutch showed no evidence of trouble from residual magnetism, and stopped the table with remarkable accuracy, bringing it to within a fraction of an inch of the same point each time the reversal was made. With the arrangement shown a variable speed motor was used.

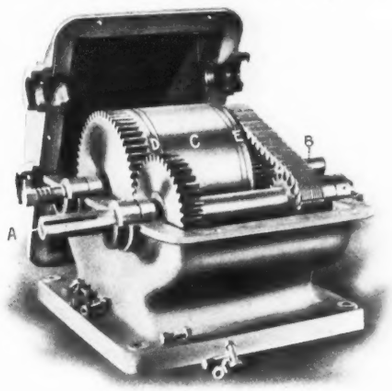


Fig. 1. Electric Reversing Clutch, with Cover Removed.

The driving gears and chains run in oil. The clutch does not need adjustment, is dust proof, noiseless and self lubricating. The exciting current may be varied so that the clutch will transmit a given power and will slip when the load is exceeded. The use of this device is, of course, not confined to planer reversing mechanisms, but may be used as well for a main line coupling, as a clutch pulley on the countershaft to drive individual machines, or as a disconnecting or reversing clutch on automobiles, hoisting engines, etc. In such cases a push button takes the place of the usual clutch lever.

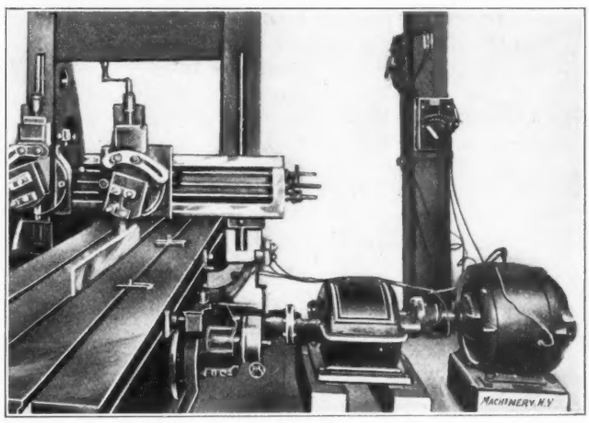
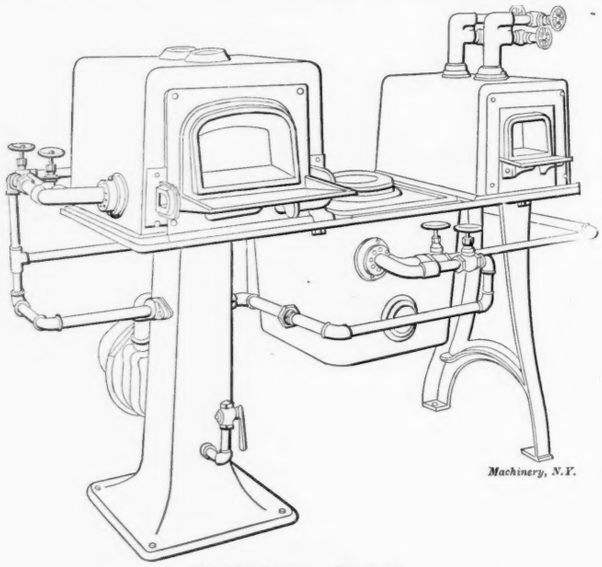


Fig. 2. Electric Clutch Applied to Planer.

COMBINATION GAS FURNACE.

The furnace shown in the cut combines a muffle furnace, a forge and a crucible furnace. In the muffle section the flame is projected from a double burner into the chamber encircling the muffle. The design of the lining is such that a rotary motion is imparted to the flames, distributing the gases over the enclosed space and heating the muffle rapidly and evenly. This is a desirable arrangement for use in heating dies, milling cutters and other expensive tools. They can be hardened perfectly without danger of cracking or overheating, because of the even temperature maintained throughout. The combustion chamber of the forge section is circular in form and so

arranged that the flame is distributed in much the same manner as is done with the muffle furnace. The crucible section is especially adapted for heating a lead bath. This may be kept at uniform temperature for an indefinite period with a minimum consumption of gas. Small pieces can be heated very quickly and by keeping the temperature of the bath at the right point overheating is eliminated and uniformity secured.



Combination Gas Furnace.

For tempering a crucible similar to that for the lead bath may be used, filled with oil and maintained at the proper heat for drawing the temper to the required point, the temperature being read from a thermometer suspended in the oil. This furnace is made by the Chicago Flexible Shaft Co., Chicago, Ill.

* * *

ANNUAL CONVENTION OF THE NATIONAL METAL TRADES ASSOCIATION.

The eighth annual convention of the National Metal Trades Association was held at Cleveland on Wednesday and Thursday, March 21 and 22, with headquarters at the Hollenden. There was a large attendance with an unusually representative list of members from nearly every section of the country. The first regular session was on Wednesday morning, but previous to this the officers and members of the council had been clearing the boards of routine business so that action upon important matters was not delayed by mere business routine when the convention actually opened.

On Wednesday morning's session, following the usual address of welcome, came the reports of the officers showing the association to be in good financial condition and that the membership had increased very largely during the past year. Secretary Wuerst's report laid special stress on the fact that the work of the association has been almost exclusively confined to preventing, rather than combating strikes, and that the efforts in this direction had worked as much for the benefit of the employees as for the employers; and it has been demonstrated that the association will stand by and aid employees in securing their rights. Favorable comment was also made on the results secured through the special contract operatives employed by the association. These services are made use of by the association previous to the calling of and during strikes when their suggestions as skilled mechanics have resulted beneficially in many ways.

One of the most important questions to come before this year's meeting was that of a plan for co-operation between the National Metal Trades Association and National Founders Association. The committee appointed a year ago formulated a plan that had been adopted by the councils of both associations and was adopted at the last meeting of the National Founders Association, the contention being that it would save a heavy expense in the administration of the business of the two organizations. It was recommended that both associations should hold the annual convention at the same place, on consecutive days, that the offices of both should be in the same building and under the same direction; and that while the officers could be independent, the work of the two societies should be carried on jointly as far as possible. The report brought out an extended discussion, the general trend of which was that while co-operation was favored, there were serious objections to any action which might terminate in an actual combination of the two organizations.

On Thursday the subject of profit sharing was discussed, and several sets of resolutions were passed relating to industrial questions. Approval was expressed of a foundry school recently established at Indianapolis under the direction of the National Founders Association, and extended resolutions were passed relating to the bill now before Congress looking to the adoption of the metric system in government work. The resolutions strongly opposed this, stating that the Metal Trades Association as a body, and also its individual members, objected to the adoption of the metric system as the one legal standard of weights and measures. In the various resolutions passed and in the discussions a sentiment of fairness toward labor and labor organizations existed, but with it a determination to hold firmly to right industrial principles.

The officers elected for the ensuing year are as follows; President, W. D. Sayle, Cleveland Punch & Shear Works, Cleveland, Ohio; First Vice-President, M. H. Barker, American Tool & Machine Co., Boston, Mass.; Second Vice-President, F. K. Copeland, Sullivan Machinery Co., Chicago, Ill.; Treasurer, William Lodge, The Lodge & Shipley Machine Tool Co., Cincinnati, Ohio.

On Wednesday evening there was a dinner given by the manufacturers of Cleveland at the Hollenden; and following the dinner were the usual speeches by several prominent people.

* * *

Announcement is made of the purchase from the Industrial Press, publishers of MACHINERY, of the Mechanical Index, by the Donnell-Colvin Co., 256 Broadway, New York. Mr. Donnell was for eleven years with the Hill Publishing Co., engaged in various capacities upon the *American Machinist* and *Power*. Mr. Colvin was the first editor of MACHINERY, and later was with *Locomotive Engineering* in both editorial and business capacities. The members of the Donnell-Colvin Co. are therefore well equipped to take up the publishing and distributing of an important work of the character of the Mechanical Index. They know the mechanical field thoroughly, are in constant touch with it through the Derry-Collard Co., publishers and book sellers, with whom they are associated, and under their management the Index should become invaluable to every person wishing to reach the mechanical trade. The volume as it now stands comprises over nine hundred pages of manufacturers of machinery and mechanical devices, all carefully classified and indexed for convenient reference, and is the best directory in its field. It is the purpose of the Donnell-Colvin Co. to keep this list strictly up to date, to add to it from time to time as mechanical development requires, and to maintain it as a complete and thoroughly reliable directory of manufacturers of machinery, tools and allied apparatus.

* * *

The Cincinnati Lathe & Tool Co., of Cincinnati, Ohio, which has recently been incorporated for the purpose of manufacturing lathes and other machine tools, has purchased the lathe business of the Fosdick Machine Tool Co., of the same city. Their specialty is a sixteen-inch lathe equipped with the well-known feed device patented by W. T. Emmes. The president of the new concern, Mr. W. C. Heindel, has been connected with the Cincinnati Milling Machine Co. for ten years past; while Mr. A. B. Sowden, the superintendent, has been building lathes for twenty years. The shops of the concern are located in the heart of the machine tool district of the city. They are being equipped with new high-grade machinery, and will be in running order by April 1st, 1906. The company is now in a position to book orders for future deliveries, which will be given their most careful attention.

* * *

The National Machine Tool Builders' Association will hold their spring convention at Atlantic City on May 1 and 2. The headquarters will be at the Chalfonte Hotel. In the call for the meeting, the secretary states that there is a manifest feeling that this convention should be strictly for business to give ample opportunity for the several committees to confer and discuss such matters as are pertinent to their peculiar subjects, and later report to the full convention.

* * *

The inside flange of channel and I-beams has a rise of 2 inches per foot, or angle of about 9½ degrees with the base.

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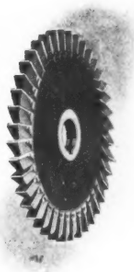

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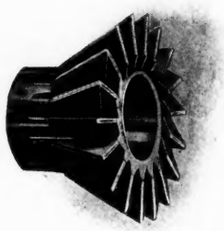

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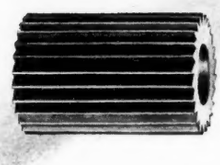

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FRESH FROM THE PRESS.

LINK MOTIONS, VALVES AND VALVE SETTING, by Fred H. Colvin. 82 pages, 4 x 6 inches, 43 cuts. Bound in limp cloth covers. Published by the Derry-Collard Co., 256 Broadway, New York City. Price 50 cents.

This little book, for the most part, is a reprint of a series of articles first published in RAILWAY MACHINERY. It is clearly written and should be a work much appreciated by men who have little time or inclination for mathematicl calculations, but who would like to get a clear comprehension of the principles of the link motion valve setting, lap and lead, piston valves, etc. The book also contains a short chapter illustrated with diagrams showing the principles of the Joy, Allen, Walschaert and Gooch valve gears.

A WIRING HANDBOOK. By Cecil P. Poole. Published by the MacGraw Publishing Co., New York. Pocketbook size, bound in leather, with 32 tables, mostly on folding sheets. Price $1.00.

This is probably the most satisfactory book published giving tables for wiring. In addition to the tables is a brief treatment of the subject of wiring, giving calculations, and showing the proper connections under different conditions for both alternating and direct current, and also giving a digest of underwriters' rules for inside wiring. The book is broad enough in its scope to be of use both to wire men who have occasion to lay out their own work and to engineers who make up wiring plans and specifications.

NEW TRADE LITERATURE.

FOX MACHINE CO., Grand Rapids, Mich. Catalogue No. 29, describing and illustrating various types of Fox millers.

THE BULLARD MCH. TOOL CO., Bridgeport, Conn., have received their catalogue No. 31 from press and will be glad to send it to all persons interested.

RIVETT LATHE MFG. CO., Boston, Mass. The new 1906 catalogue of Rivett Lathes illustrates and describes many of the different types and includes price list for same.

GISHOLT MACHINE CO., Madison, Wis. Leaflet showing a big bore 24-inch lathe with 6¼-inch spindle hole. The strong points of the Gisholt big bore lathe are clearly set forth.

THE STANDARD WELDING CO., Cleveland, O. Three booklets treating of the process of Electric Welding. The production of seamless steel tubing and seamless steel rings by this process is described.

FAY & SCOTT, Dexter, Me. Catalogue No. 13, of Extension Gap Engine Lathes. The special features of these machines are set forth and specifications and illustrations for a number of the types are given.

JAMES CLARK, JR., & CO., Louisville, Ky. Booklet describing "Willey" electrically driven grinders and breast drills. It shows how these machines can be adapted for center grinding, surface grinding, cutter grinding, internal grinding, cylindrical grinding, etc.

THE GARVIN MACHINE CO., Spring and Varick Streets, New York City, have issued a booklet as a "reminder of the Garvin product," which illustrates a number of their milling machines, grinders, lathes, presses, etc.

ELECTRO-DYNAMIC CO., 11 Pine Street, New York City. Circulars Nos. 22 and 23 describing the Inter-Pole Variable Speed Motor, which is especially adapted for driving fans and blowers. Ratings and diagrams for the various frames are given.

THE RIDGWAY DYNAMO & ENGINE CO., Ridgway, Pa. Bulletin No. 17, describing the McEwen engine. Tables of specifications for Simple and Compound Engines and the Horse Power of same at various speeds, pressures and points of cut-off are given.

KEUFFEL & ESSER CO., 127 Fulton and 42 Ann Streets, New York City, have issued the 1906 edition of their catalogue. This is as usual very complete, showing many of their drawing materials and surveying instruments, prices for which are quoted. A number of views in their factories are shown.

B. F. BARNES CO., Rockford, Ill. New 1906 catalogue of Twentieth Century Machine Tools. Many types of drills are illustrated and specifications given for each and some of their various chucks and lathes are also described. This catalogue is more complete than any of the previous issues and is well worth looking over.

INGERSOLL-RAND CO., 11 Broadway, New York City. Catalogue No. 45, describing completely the Ingersoll-Sergeant rock drills, their various parts and operation. The catalogue is well illustrated, two of the plates showing the use of these machines in the construction of the Hudson River Tunnel and the Eastern Chinese Railway.

THE WHITMAN & BARNES MFG. CO., Chicago, Ill. Catalogue describing their complete line of twist drills, reamers, screw and drop forged wrenches and various other supplies which they manufacture. A convenient feature of the catalogue is the index in the front by means of which the description of any tool may be quickly found.

THE POWER & MINING MACHINERY CO., Milwaukee, Wis., have issued a pamphlet, attractively illustrated by means of diagrams and colored plates, describing the Loomis-Pettibone Generating plants. This system gasifies bituminous coal, wood, charcoal, lignite, etc., and produces a gas that is particularly adapted to the operation of gas engines.

H. B. UNDERWOOD & CO., 1025 Hamilton Street, Philadelphia, Pa., manufacturers of special tools for railway repair shops, announce that they are sending copies of "Link Motion," by Colvin, to all master mechanics and superintendents of motive power of the various railroad companies. This little volume is one recently issued by the Derry Collard Co., New York, and is noticed in another column of this issue.

THE GOLDSCHMIDT THERMIT CO., 43 Exchange Place, New York City, have issued a pamphlet giving instructions for welding wrought iron and steel pipes by utilizing the heat of the thermit. The theory, application and operation are treated of and a price list of standard weight pipes, extra heavy pipes, etc., is given. All those interested in this process should obtain a copy of the pamphlet.

THE GEO. V. CRESSON CO., Philadelphia and New York. Pamphlet entitled Rope Driving, in which are described the Cresson apparatus for transmission of power by ropes with illustrations of rope wheels, shives, idlers, etc. They have also added a short treatise on rope driving containing practical data upon horse power transmission, methods of connecting up drives for different arrangements of shafting and pulleys and the proportions of grooves for rope wheels. The pamphlet is handsomely gotten up and illustrated.

THE BROWN & SHARPE MFG. CO., Providence, R. I. The 1906 edition of their general catalogue has been issued in its usual form, pocket size, containing over 500 pages. Besides illustrating, describing and listing the machines and tools made by this firm the catalogue contains the usual number of valuable tables which many machinists and mechanical men depend upon for reference. Among the improvements listed are geared feeds, new design of spiral heads, etc., for milling machines. Several sizes of milling machines have been added and a number of new attachments; also a new size and type of automatic gear cutting machine. Numerous small tools, cutters, etc., have been added to the already large list, and the following machinists' tools: Inside micrometer calipers, micrometer set, from 0 to 6 inches, adjustable center punch, machinists' center punch, universal dividers, steel beam trammels and scribers.

The American Locomotive Co., 111 Broadway, have just issued in 6 x 9 pamphlet form a paper on four-cylinder balance compounds read before the Railway Club of Pittsburg by Mr. F. J. Cole. This paper begins with the presentation of the reasons for the wide interest now taken by railroad men in various types of four-cylinder compounds and this is followed by carefully prepared historical treatment of the early stages of the development which led up to the very successful four-cylinder compounds of the present time. The author presents diagrams from early patent specifications and gives dates of the turning points in the development. By means of a number of engravings the subject of crank axles is carefully recorded. Among the engravings are several illustrating well-known English, French and American four-cylinder compounds, and the Cole system receives prominent mention. This pamphlet, besides being historical, contains quotations and descriptions of the best foreign practice, as well as that of the company with which the author is connected.

MANUFACTURERS' NOTES.

THE DIAMOND MCH. CO., Providence, R. I., have arranged to open a New York salesroom at 18 Dey Street in charge of H. F. Frevert

THE TOLEDO MCH. & TOOL CO., Toledo, O., are erecting a 100 x 100 addition to their factory.

THE BURKE MACHINERY CO., Cleveland, O., have recently purchased the B. & C. Metal Saw Business, formerly owned by The Baker-Resek Machine Tool Co., Cleveland.

J. H. WAGENHORST & CO., manufacturers of automatic electric blue printing machines, have recently removed from Youngstown, Ohio, to the Gazette Building, Pittsburg, Pa.

THE SCHAEFFER & BUDENBERG MFG. CO., 23 Dey St., New York City, have entirely reorganized the management of their business and have purchased a new plant at Foxboro, Mass.

THE CROCKER-WHEELER CO. have now under construction in their shops at Ampere, N. J., four 4,000 K. W., 3-phase, 60-cycle, 6,600-volt alternating current generators which will be installed at the lower end of the Sanitary and Ship Canal, Lockport, Ill.

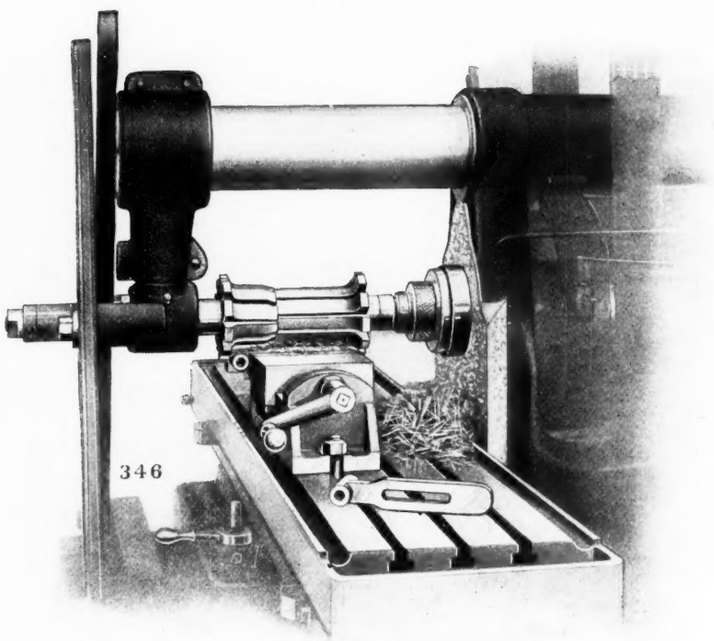
THE NEW ERA MFG. CO., Kalamazoo, Mich., report an extra large business this year in metallic phosphoro. This metal is used extensively in brass foundries as a deoxidizing agent, and is also used as a retempering agent for babbitt metal.

THE TOLEDO MACHINE & TOOL CO., Toledo, O., have recently secured an order for a drop forging equipment which, when shipped, will amount to fifteen or more car loads of machinery. This company is doing a large business in supplying drop forging equipments for which there is at present an unusual demand throughout the country.

THE SPRAGUE ELECTRIC CO., 527 W. 34th Street, New York City, have recently taken an order from the City Steam Laundry, Yonkers, N. Y., for an equipment comprising a generator, switchboard and six motors. The large laundry machines in the new Knickerbocker Hotel, New York City, are to be driven by Sprague electric motors.

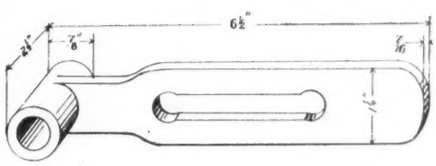
THE NORTHERN ENGINEERING WORKS, Detroit, Mich., have recently supplied to the foundry of the Holland Radiator Co., Bremen, Ind., about 1,700 feet of overhead trolley track with hangers, curves, switches and trolleys, comprising a modern overhead foundry distributing system.

The No. 3 Plain Double Back Geared Cincinnati Miller



fitted with formed cutters 3¼″ diameter, mills one edge of these pieces at a single cut, at a table travel of 1½″ per minute. Two cuts suffice to furnish all the irregular surfaces complete. The speed of the cutter is 50 r.p.m., and a feed of .030″ per turn leaves a good finish.

This class of work is especially severe, and requires a machine of ample spindle power, adequate arbor supports, rigid knee, stout table and correctly designed bearings throughout. Let us tell you how our machines compare with others in these details. We invite correspondence.



WE ARE MILLING SPECIALISTS

The Cincinnati Milling Machine Company

CINCINNATI, OHIO, U. S. A.

European Agents—Schuchardt & Schutte, Berlin, Vienna, Stockholm and St. Petersburg. Alfred H. Schutte, Cologne, Brussels, Liege, Paris, Milan, Turin, Bilbao, and Barcelona. Chas. Churchill & Co., London, Birmingham, Manchester, Newcastle-on-Tyne and Glasgow. *Canadian Agents*—Williams & Wilson, Montreal. H. W. Petrie, Toronto.

THE CHICAGO FLEXIBLE SHAFT CO., Chicago, Ill., have received an order for the installation of one of their No. 9 furnaces with blower in the United States Mint, Washington, D. C. Only furnaces of the highest standard are accepted for this purpose. The company have supplied the government with several of this and other types of furnaces.

THE FREVERT MACHINERY CO., 18 Dey Street, New York, are manufacturing a line of newly designed Hand Power Cranes, Trolleys, Hoists and Overhead Tracks, which combine many valuable improvements and new features. Mr. H. F. Frevert, the principal of the company, has been for many years identified with the machinery trade, and is widely known among manufacturers and buyers.

THE NORTHERN ELECTRICAL MFG. CO., Madison, Wis., produce electrical equipment which is characterized by ease of application and convenience of arrangement, location and operation. A special type of variable speed motor, described in bulletin 45, has been developed for certain classes of work. Northern Multi-Speed Motors, as they are termed, are especially designed for application to engine lathes. The bulletin will be sent promptly on request.

THE E. G. SMITH CO., Columbia, Pa., successors to E. G. Smith, manufacturer of the Which Way Pocket Level and other fine tools, are now doing business in their own building, and hope that their increased capital and improved facilities will enable them to fill orders promptly and keep pace with their rapidly growing business. They will be pleased to send particulars of any of their tools, among which is included the well-known Columbia sliding caliper, to all who are interested.

GEO. H. BAUSH has resigned his position of general superintendent of the Baush Machine Tool Co., Springfield, Mass., which position he has held since he first became connected with the company, a period of twelve years. Previous to that he was vice-president and general superintendent of the C. H. Baush & Sons Co., Holyoke, Mass., and was also connected with the Baush & Harris Co. Mr. Baush will retain his financial interest in the Baush Mch. Tool Co. He announces that his plans for the future are not yet definitely formed.

THE QUINCY, MANCHESTER, SARGENT CO., 114 Liberty Street, New York City, has been incorporated and will take over the business and plant of the Railway Appliances Co. This also includes the business and plant of the Pedrick & Ayer Co., Plainfield, N. J., manufacturers of locomotive repair tools, electric and pneumatic hoists and cranes and pneumatic riveters. The Quincy, Manchester, Sargent Co. will also act as sole selling agent for the product of the Elastic Nut & Bolt Co., Milwaukee, Wis.

THE MAIN BELTING CO., Philadelphia, Pa., as a result of the popularity and increasing demand for Leviathan belts are compelled to make a considerable addition to their already well-equipped plant. Their increased facilities will greatly enlarge their output and will enable them to keep pace with the demand for their product. The company issues a booklet treating of the make up and capabilities of their output, which they will be glad to send to anyone who desires to investigate the claims of this power transmitter.

THE POWER & MINING MACHINERY CO., Milwaukee, Wis., in order to keep pace with their rapidly increasing business, have awarded contracts for the erection of additions to their shops at Cudahy, that will, when completed, more than double their present capacity. These improvements will cost upward of $300,000, and will include a 200-foot extension to their foundry, the installation of a considerable number of machine tools of special design, and an increase in their shop force of nearly 300 men, making the total number employed about 1,000.

THE DAYTON MACHINE & TOOL WORKS, Dayton, Ohio. Catalogue of Universal Cutter and Tool Grinder; illustrated. The machine shown in this catalogue consists of a cutter grinder with a head and tail stock mounted on a table with longitudinal traverse and an emery wheel on an adjustable cross slide, similar to the usual type of universal grinder. By swinging the wheel head around, an internal grinding fixture is brought into place and the head and tail stock can be removed and several types of cutter and tool holders mounted on the table, thus adapting the machine to grinding all kinds of cutters and reamers and similar tools.

THE STANDARD ROLLER BEARING CO., Philadelphia, Pa., have increased their capital from $2,000,000 to $3,500,000. This increase was necessary in order to provide for the enlargement of their plant, which will consist of a four-story factory for the manufacture of annular ball bearings, on which the company holds basic patents. The new factory will be erected immediately. During the past year the Standard Roller Bearing Co. have made many additions to their equipment, among these being the installation of machinery in a four-story building, the erection of an iron foundry, hardening and tempering building, and crucible steel castings plant. With the force for the new addition the employes of the company will number over 1,000.

MISCELLANEOUS.

Advertisements in this column, 25 cents a line, ten words to a line. The money should be sent with the order. Answers addressed to our care will be forwarded. Original letters of recommendation should not be enclosed to unknown correspondents.

A MACHINIST WANTED in every shop to sell my Calipers and Levels. Liberal proposition. Address E. G. SMITH CO., Columbia, Pa.

A MANUFACTURING CONCERN having a varied line of machinery wish to dispose of one of their lines, which consists of stationary gasoline engines. These engines run in sizes of from 2 to 30 H. P., and are adapted for all kinds of work. Business in this line has run $50,000 a year. Patterns, drawings and good will will be sold at a reasonable figure. Parties desiring to add another line to their business, or those desirous of going into the manufacturing business will find this to be an interesting proposition. Address GAS ENGINE, care MACHINERY, 66 West Broadway, New York.

AN OLD-ESTABLISHED WHOLESALE FIRM in London whose business takes them among hardware dealers and ironmongers throughout Great Britain is open to accept an exclusive agency for any machine, tools or implements that would work in with their present business. Apply Box 100 C., Dawson's Advertising Offices, Cannon Street, London, E. C., England.

"DIES AND DIE MAKING."—A practical book, $1.00. Send for index sheet. J. L. LUCAS, Bridgeport, Conn.

DRAFTSMEN AND MACHINISTS.—American and foreign patents secured promptly: reliable researches made on patentability or validity, twenty years' practice; registered; responsible references. EDWIN GUTHRIE, Corcoran Building, Washington, D. C.

DAILY BULLETINS of vacant positions for draftsmen, foremen, engineers, superintendents and salesmen. Stamp. CLEVELAND ENGINEERING AGENCY, Rose Building, Cleveland, Ohio.

ENGINE LATHE, 10-inch, at wholesale price, also tools. Send 10 cents for a set of Magic Rolls to TIBBETTS, Putnam, Conn.

ENGINEERS, DRAFTSMEN and TECHNICAL MEN, including superintendents, foremen, inspectors, should send for this week's issue of The Engineering Agency Bulletin in which is listed each week from 200 to 500 positions of the foregoing class of men at salaries ranging from $1,000 to $5,000 a year. The Bulletin is sent regularly to those paying the cost of mailing. Send for sample copy to-day. ENGINEERING AGENCY, 1208 Monadnock, Chicago.

FOR SALE.—1,000 steam and water gauges at $1.00 each. Send for list to J. L. LUCAS, 2 Fox Street, Bridgeport, Conn.

FOR SALE.—Air Furnace, 50-ton Patent Wellman Rolling Furnace, suitable for malleable iron or air castings. In good order. Will be sold cheap for want of use. Address Box 56, care MACHINERY, 66 West Broadway, New York.

FOR SALE.—1-12 Point Waggoner Watchman's Clock, and 1-20 Point Waggoner Watchman's Clock. Thirty-two magneto boxes for same. All in first-class shape. Will sell at a reasonable price. If interested, address Purchasing Department, OLDS MOTOR WORKS, Lansing, Mich.

HELP WANTED.—The works of the Russell, Burdsall & Ward Bolt and Nut Co. are located at Port Chester, N. Y., a delightful residential town 26 miles from New York on the shores of Long Island Sound. They have places open for a number of first-class all-around machinists. Their business is rapidly increasing. They are constantly adding to their equipment, and require additional force to build new machines and take care of existing equipment. Steady work is assured for intelligent, capable and reliable men. References and qualifications required.

INSIDE BUSINESS PARTNER with $7,000 to $10,000 desired for half interest in old machine and tool business, growing too large for owner. Volume $50,000. Pay 25 per cent. dividends. Address Box 57, care MACHINERY, 66 West Broadway, New York.

MACHINISTS.—Pointers and rules, full as a nut, try it; 25 cents, stamps accepted. WM. POWLES, 693 Otsego Street, St. Paul, Minn.

MACHINISTS WANTED.—Good floor, planer and lathe hands. Good wages and steady employment to competent men. Saturday half-holiday during summer. GEO. D. WALCOTT & SON, Jackson, Mich.

PATENTS.—H. W. T. Jenner, patent attorney and mechanical expert, 608 F Street, Washington, D. C. Established 1883. I make an examination free of charge and report if a patent can be had and exactly how much it will cost. Send for circular. Member of Patent Law Association.

SHOP AGENTS WANTED.—You can make good money selling our mechanics' hand soap in paste form. Gives better results and cheaper to use than any other kind. Free sample and terms sent on request. CHAPIN & SON CO., Reading, Mass.

THE POINT IS JUST THIS!—Are you dissatisfied with your present position—or have you an employee who is unsatisfactory. In either case, where could you better turn for relief than to a corps of trained employment experts. We have secured better positions for thousands of men, and have supplied thousands of employers with competent men. Why hesitate? Booklets can be secured for the asking. HAPGOODS, Suite 511, 309 Broadway, New York City.

WANTED.—Foreman for body and running gear finishing and assembling department in large automobile works. Must have had previous experience in this line. Address Box 60, care MACHINERY, 66 West Broadway, New York.

WANTED.—Draftsman, one familiar with automobile work preferred. None but first-class draftsmen need apply. Address Box 61, care MACHINERY, 66 West Broadway, New York.

WANTED.—Second-hand 3-way tapping machine, for tapping cast-iron steam pipe fittings, ⅛-inch to 1¼-inch sizes of elbows and tees. State name of maker and quantity machine is capable of tapping per day of each size. Also state lowest cash price, also make offer on one or two brass monitors, suitable for valves, etc. Address P. O. Box B, St. John, N. B., Canada.

WANTED.—Foreman experienced in gas engine work to take charge of engine assembling department in large automobile factory. Must be a hustler and come well recommended. Address Box 58, care MACHINERY, 66 West Broadway, New York.

WANTED.—Foreman to take charge of repair department in automobile factory. Must have had experience with high-grade American and foreign cars and be able to handle men to advantage. No others need apply. Address Box 59, care MACHINERY, 66 West Broadway, New York.

WANTED.—Agents, machinists, tool makers, increase your salary. Sell Saunders' enlarged Hand Book for Practical Mechanics. A pocket-manual guaranteed to fill the bill as a ready reference and to contain more rules, shop kinks, than all the other mechanical books bound together in one volume. Secrets from note books of best mechanics in the country, will figure out by simple arithmetic problems you run up against every day in the shop. Price, postpaid, $1.00 in cloth, $1.25 in leather with flap. Agents make big profits. Send for list of books. E. H. SAUNDERS, 216 Purchase Street, Boston, Mass.

WANTED.—Manufacturing superintendent, light machine manufacturer. Good experienced men only need apply. Address "E.," care MACHINERY, 66 West Broadway, New York.

WANTED.—Situation as superintendent of concern manufacturing light or heavy machinery; 37 years old, and married. Am a practical mechanic, technical training, experience of 22 years, covering a large variety of work, designing special machines and appliances, familiar with repair work of all kinds, modern methods, reducing costs and producing results; an American, a hustler, and can handle men. Desire a change, west of Mississippi preferred. Address SUPERINTENDENT, care MACHINERY, 66 West Broadway, New York.

WANTED.—An experienced mechanical draftsman for general machine work. State experience and salary expected. Steady employment. CENTRAL IRON WORKS, Quincy, Ill.

WILL DESIGN and manufacture any machine or device. Working drawings, illustrations of machinery, tracings, blue prints, etc., made at reasonable rates. Will guarantee results. Let us figure on your work. EDW. LINDMUELLER, Williamson Building, Cleveland, O.

WORKING DRAWINGS, tracings, blue prints, and special machinery designed at reasonable rates. Work guaranteed. LEON MENZEL, Designer and Engineer, Long Island City, N. Y.